

Miller-Saunders, Kristi

From: Miller-Saunders, Kristi
Sent: November-03-17 10:51 AM
To: Taylor, Nathan
Subject: SSHI_Update Cory AMD_Nov 3 2017.ppt
Attachments: SSHI_Update Cory AMD_Nov 3 2017.ppt

I am not going to give a formal presentation, but I thought Cory might like to see the information that was provided last to the AMD and SSHI context advisory in June of this year. I will go over some of these findings verbally, and if it is helpful we could look at some specific slides on the teleconference, but I am really thinking this is something he can look at later after hearing about some of this work and findings. Too bad he cannot be here in person...it is much easier to convey that way. It is a bit overwhelming to go over the breadth of what we have done over the phone, and I won't really try. Just the key points—at least that is my intent. I am also interested in answering any questions he might have given conversations with others or what is going on in the media.

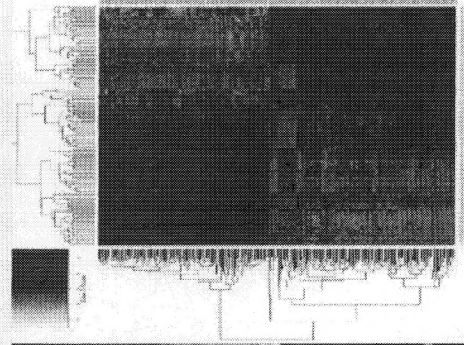
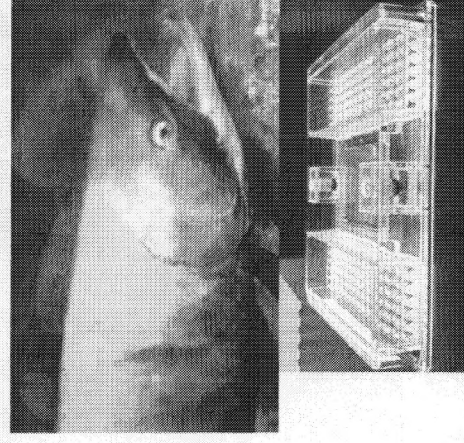
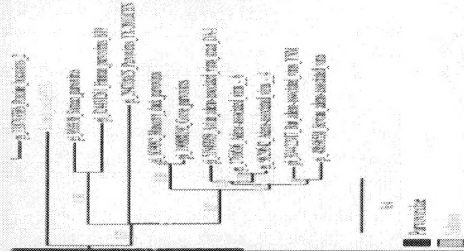
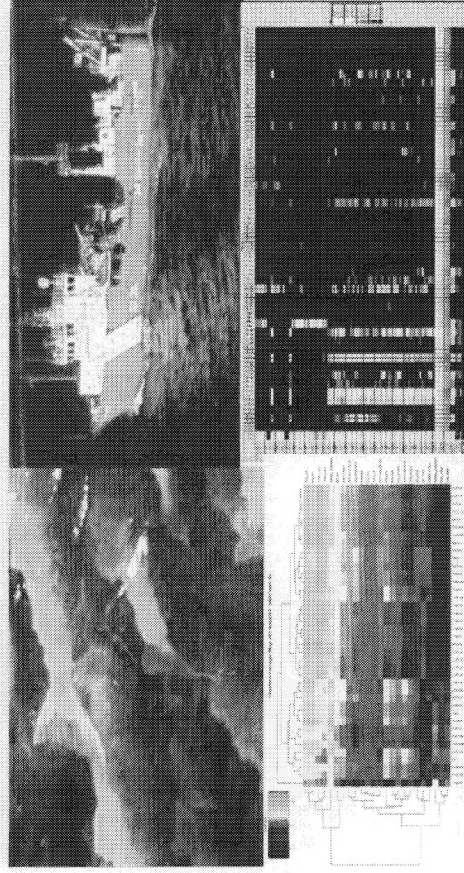
Please forward,

Kristi

Genome BC Strategic Salmon Health Initiative

Co-led by Brian Riddell (Pacific Salmon Foundation) and Kristi Miller (Fisheries and Oceans Canada)

Team includes 16 International Scientists from 6 Universities and 3 government labs
7 scientists/postdocs with veterinary degrees (2 pathologists, 5 epidemiologists)



Fisheries and
Oceans Canada



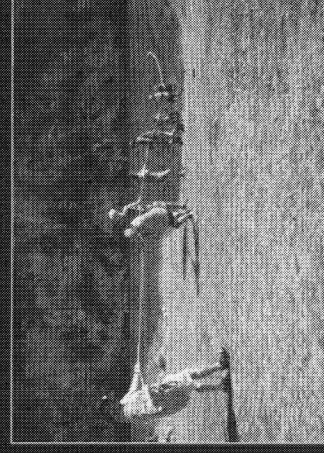
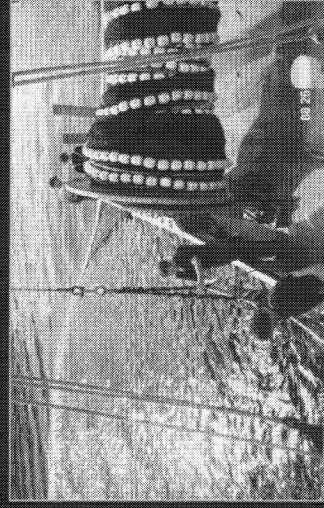
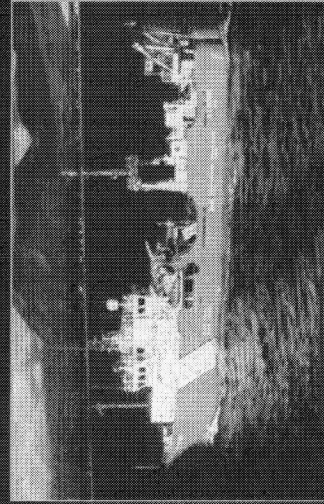
Genome
British Columbia



Kristi Miller
July 17, 2017

Overview

- Infectious agents detected in aquaculture/hatchery/wild salmon in BC
- Audit samples—merging agents with disease diagnostics
- Development of novel host biomarker panel for viral disease diagnostics (VDD)
- High throughput sequencing detects novel agents
- Salmon Fit Chips
- Next Steps
- Emiliano – in situ hybridization/HSMI-PRV research
- Gideon – Novel agents



Objective 1: Field Collections

Accomplishments to date

A. Most collections anticipated in support of the program are now completed

Aquaculture – 4,125 (930 Audit, 3,195 SSHI farm)

Wild/Hatchery smolt/juvenile – 39,000 (2008-2016)

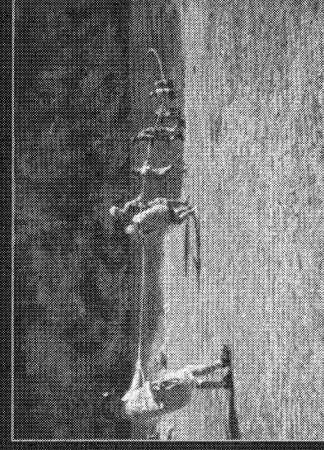
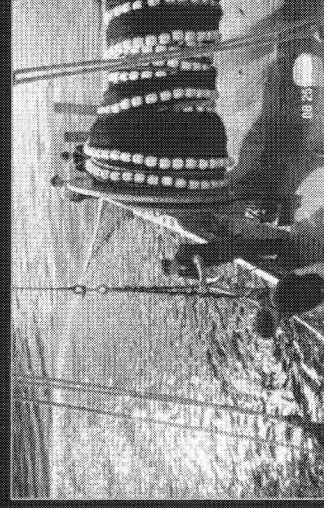
Adults – 8500 sockeye (2005-2016)

Marine fishes -- ~2000

Hakai has additional smolt samples 2015-16 taken for farm-wild interactions

B. Access Database – Sample inventory and BioMark analysis results

C. Genetic Stock Identification 78% complete (4695/6000 samples)



Objective 2: Agent Monitoring

Accomplishments to date

- ~14,000 samples of 26,000 anticipated run on the BioMark –
 - Data provided to PDFs for analysis and write-up/students writing their own data
- Three new assays added (*Tenacibaculum maritimum*, *Moritella viscosa*, *Yersinia ruckeri*) and run on Audit, aquaculture and sockeye samples
- Added Viral disease development (VDD) analysis on BioMark (25 dynamic arrays)
- Marine fish currently a focus for analysis



Parvicapsula



Ichthyophthirius



Sphaerothecum



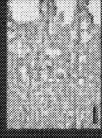
Ichthyophonus



Ceratomyxa



Parvicapsula



Paranucleospora



Parvicapsula



Tetracapsuloides



Rickettsia



VEN

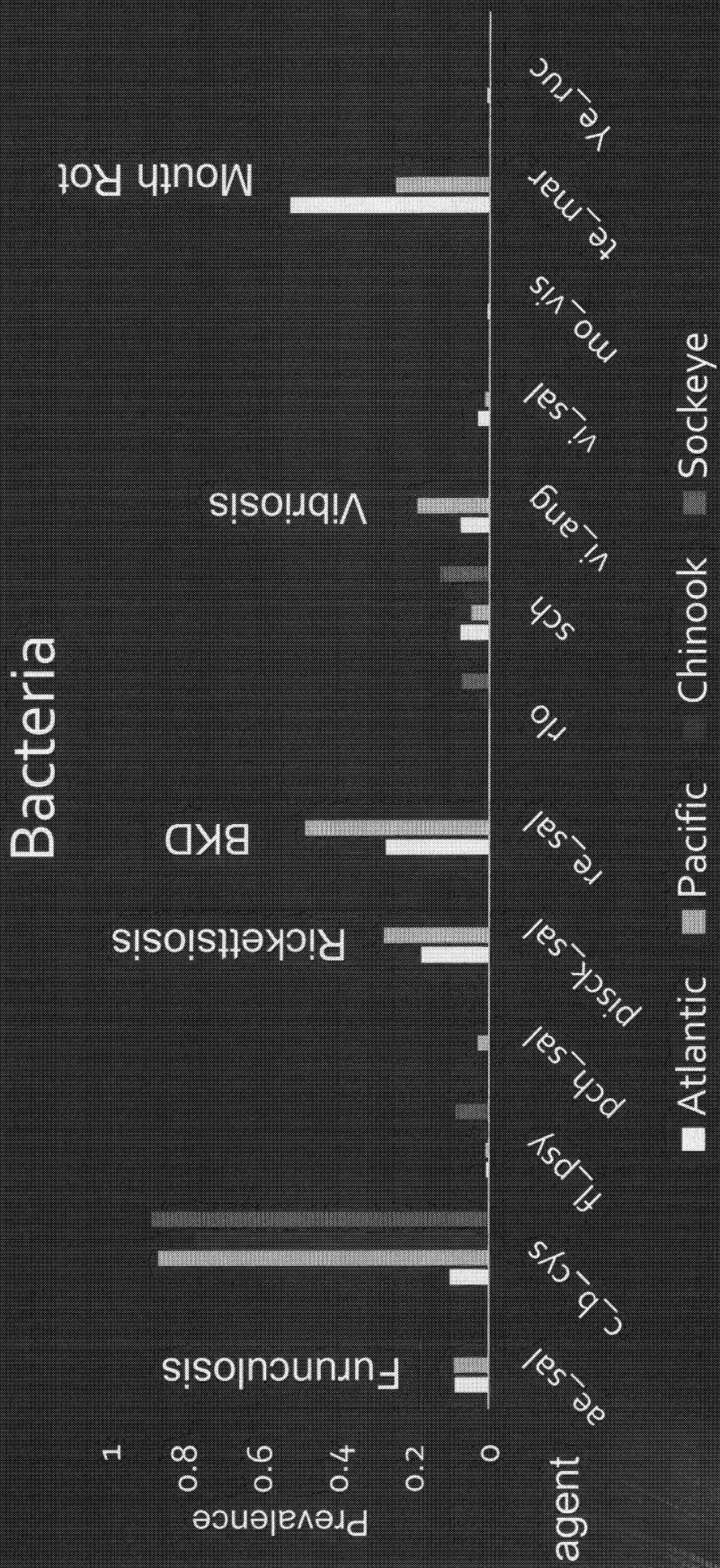


PRV

Infectious Agents Detected in BC Salmon and Herring

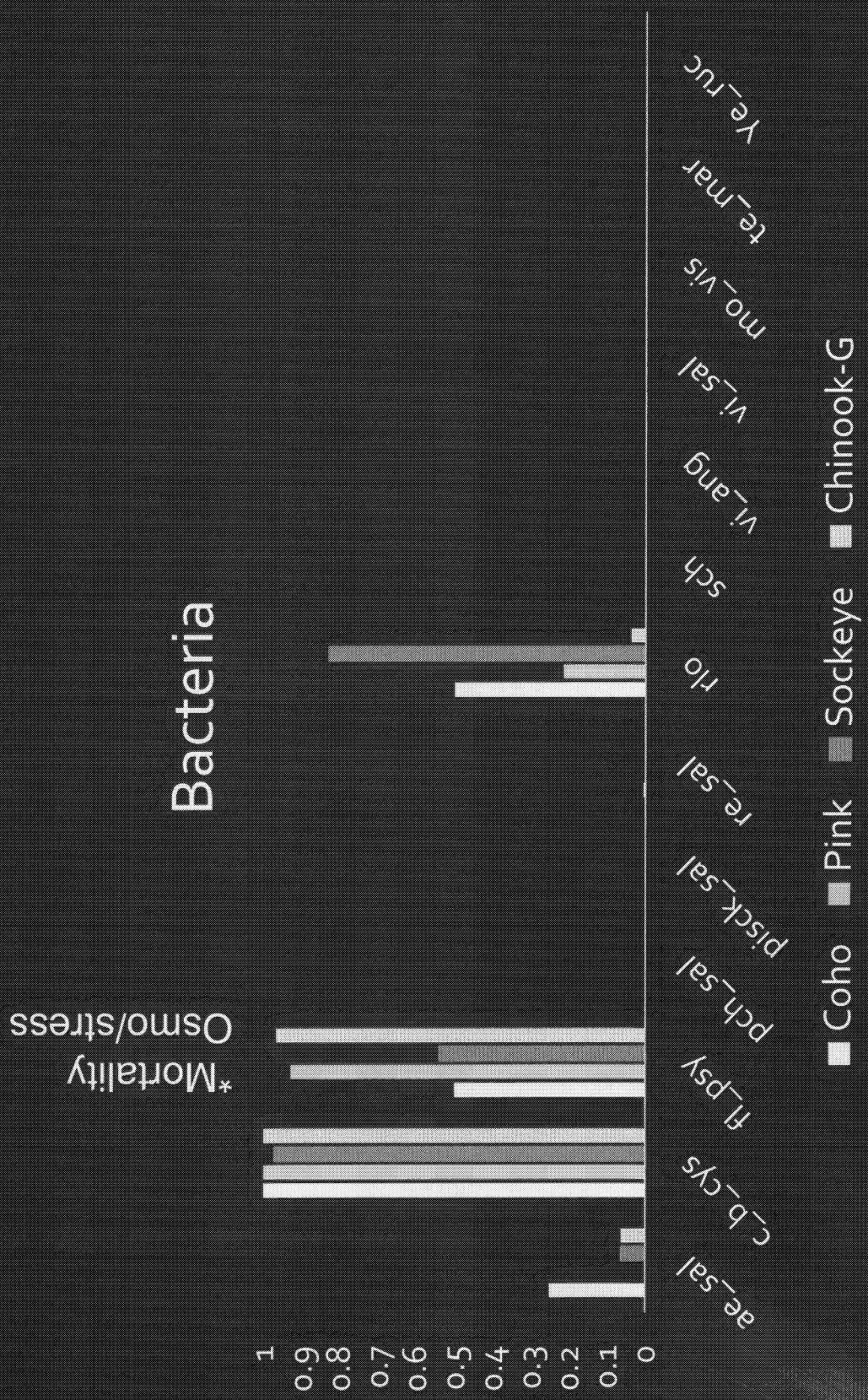


Bacterial infections and diseases are generally more common on farms than in migratory fish



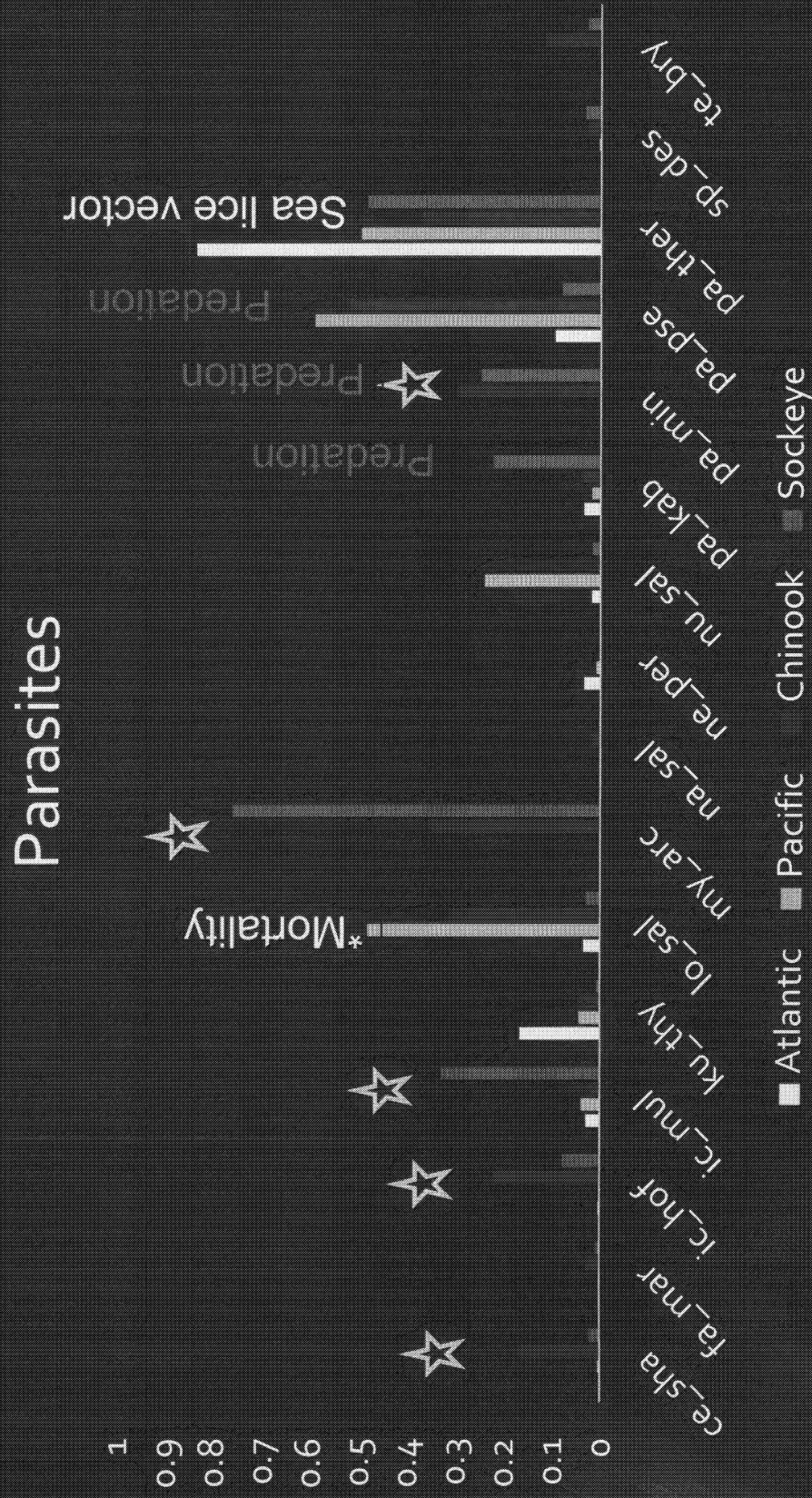
Disease names reflect common diseases on farms caused by the agents detected

Certain bacterial infections can become quite prevalent in returning adult salmon

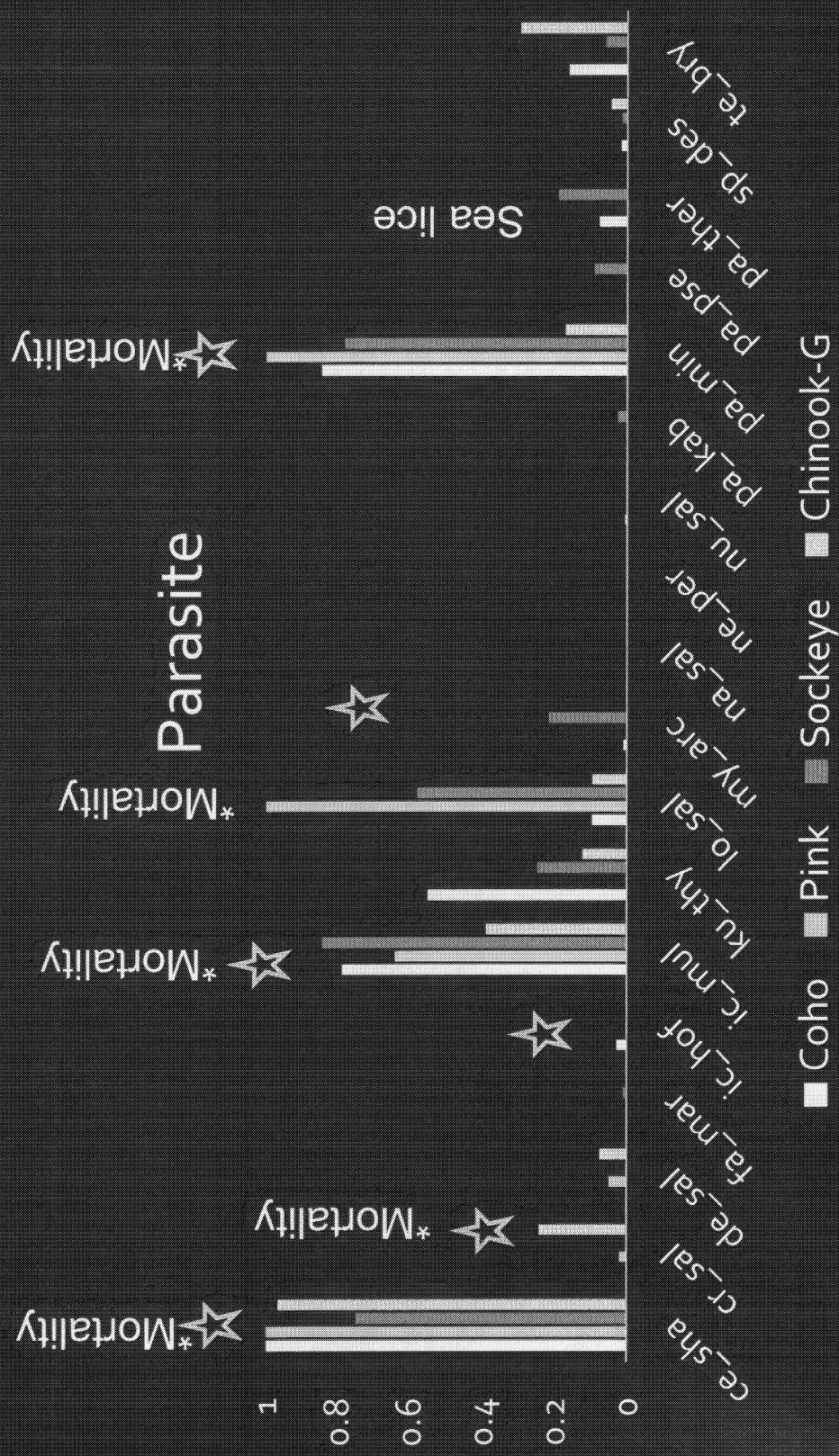


Disease names reflect common diseases on farms caused by the agents detected

Microparasitic (fungal/protist) infections are generally more common on in migratory fish than on farms and in Pacific versus Atlantic salmon, especially those transmitted in FW (starred)

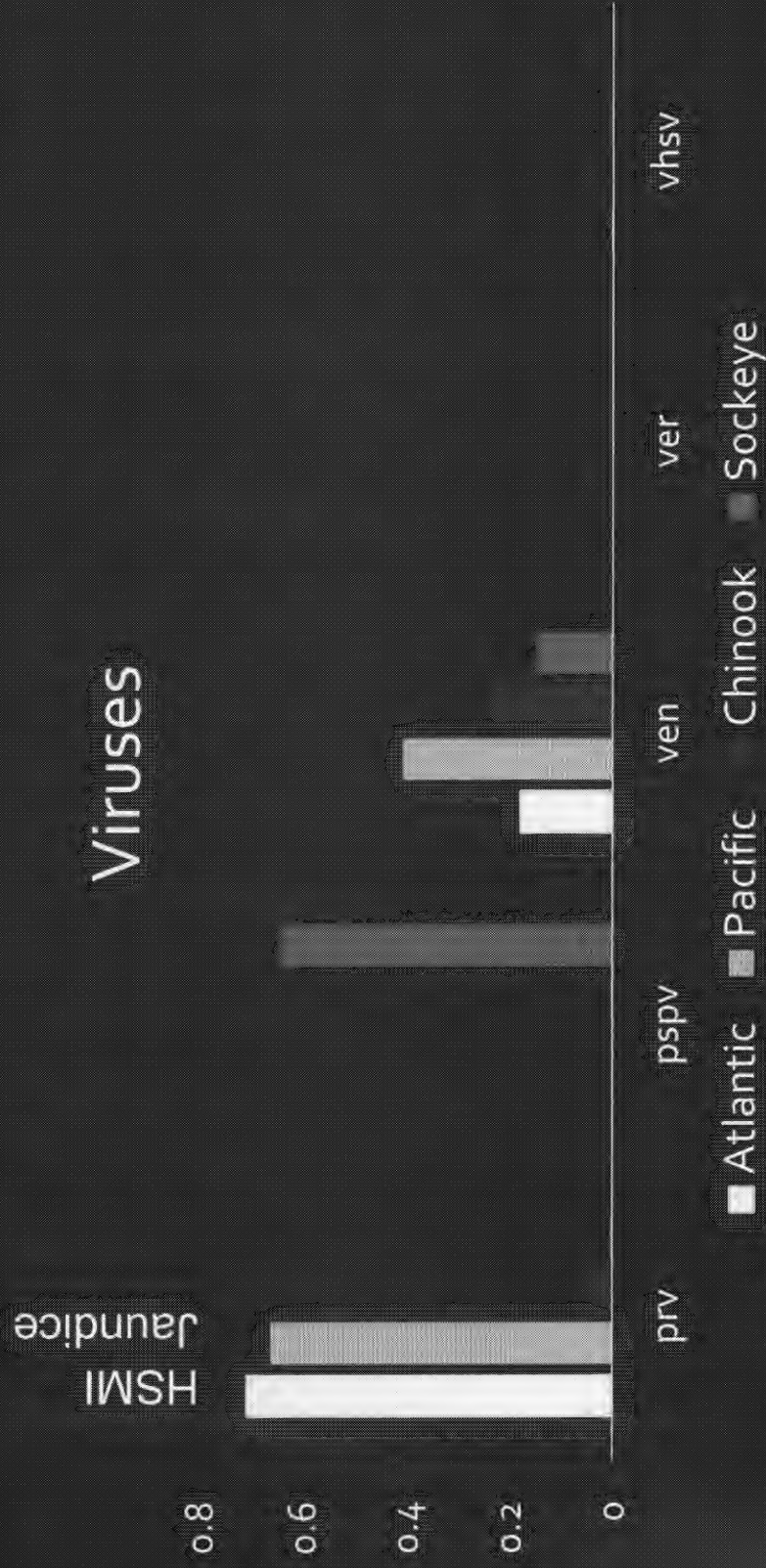


Parasitic infections increase in prevalence in return-migrating adults than in smolts. Agents transmitted in FW are starred



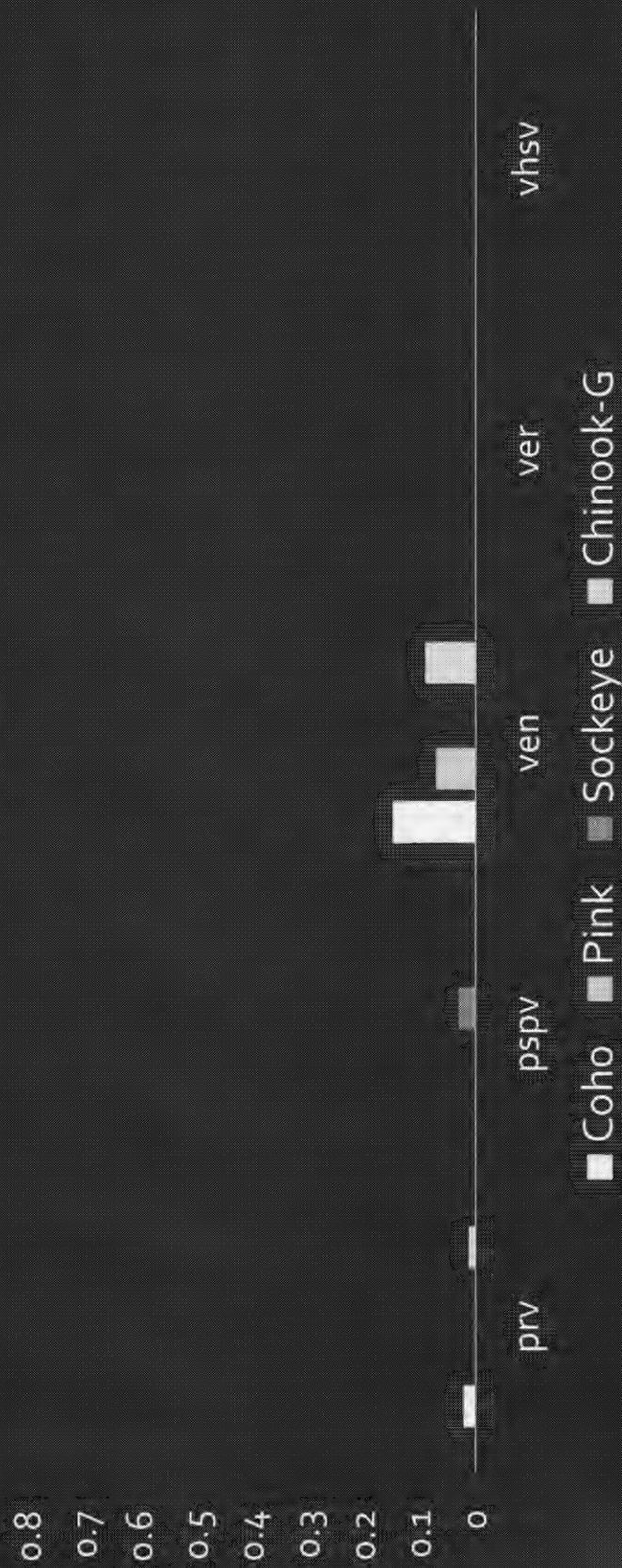
There are only a few common viruses, each with differing patterns of distribution

Only PRV is more prevalent in farm populations



Viral prevalence is low in returning adults

Virus



Infectious agents not detected (>1200 samples run)

46 agents initially included in analysis, 3 new agents (known endemics) added later (known impacts on farms) = 49 agents total

40 agents detected in BC salmon. Not detected (OIE reportable)

Viruses

ISAv – Infectious Salmon Anemia virus
IPNV – Infectious Pancreatic Necrosis virus
Omv – Oncorhynchus Masu Herpesvirus
Sav – Salmon Alphavirus
PMCV – Piscine Myocarditis Virus
ASPV – Atlantic Salmon Paramyxovirus

Bacteria

Aeromonas hydrophila

Parasites

Gyrodactylus salaris
Myxobolus cerebralis

PRV highly prevalent in farmed fish (~70% of farm audit samples)

Virus increases in prevalence over the first 6 months in the ocean, while the two diseases associated with it occur ~8 months post ocean-entry

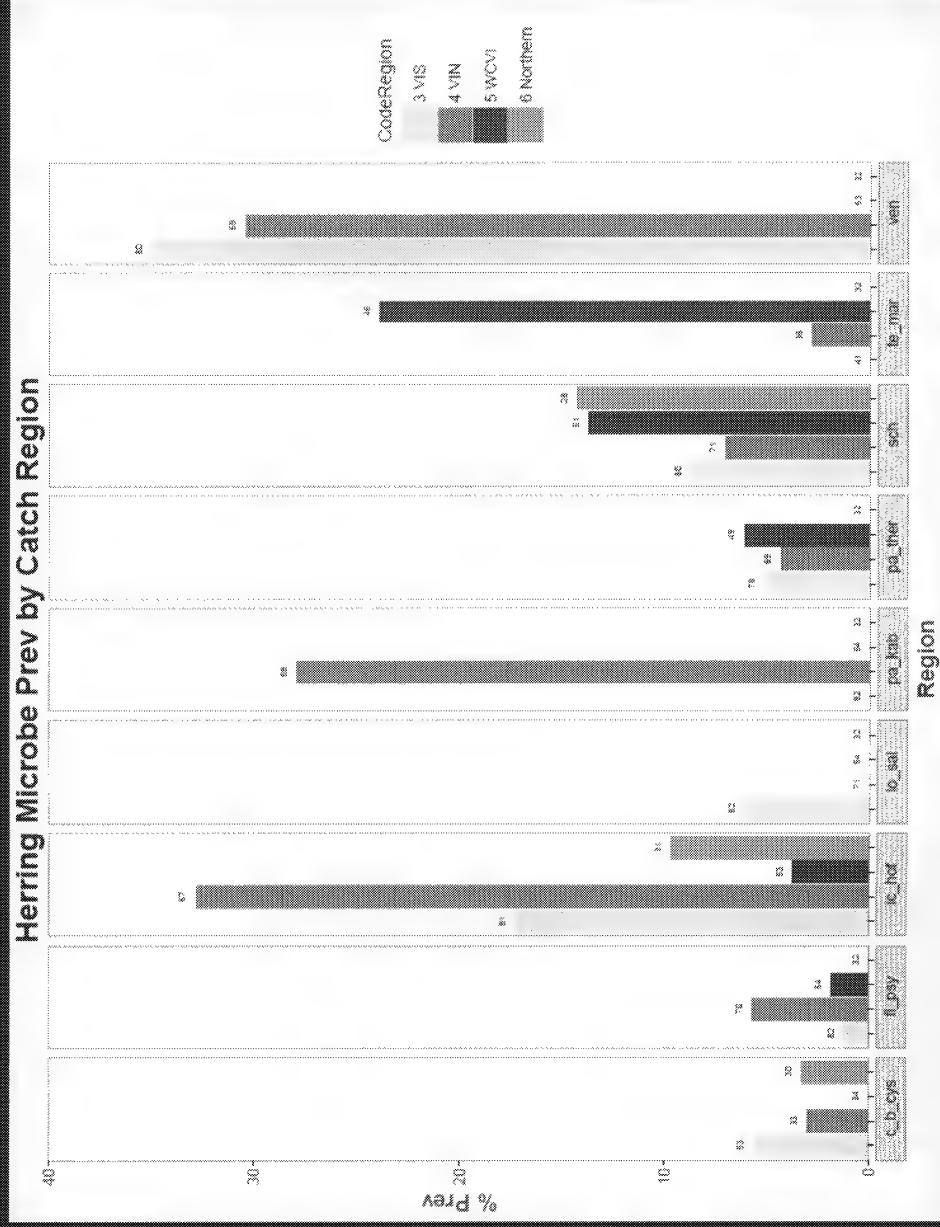


PRV detected, but NOT common, in migratory smolts

Virus increases from summer through fall/winter in Chinook and Sockeye salmon; 7% overall in Chinook and 3% in Sockeye
Mostly in fall/winter



Herring also carry a diversity of agents that infect salmon



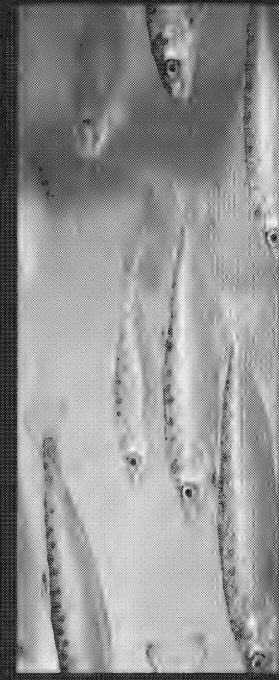
Linking Infectious Agents with Disease Diagnostics in Audit Samples and Physiological Impact in Migratory Salmon



Fisheries and Oceans Canada

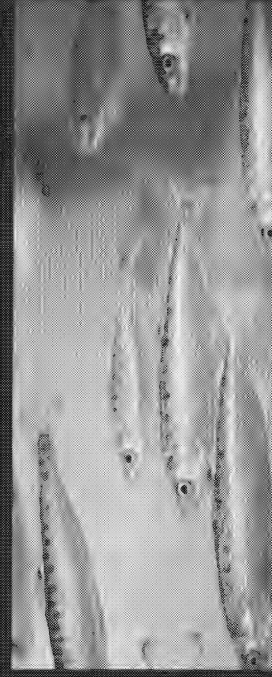
>60% of Audit fish are NOT diagnosed to a specific infectious disease

- Some may have died of environmental causes
- Many classified as systemic inflammatory response, no etiological agent



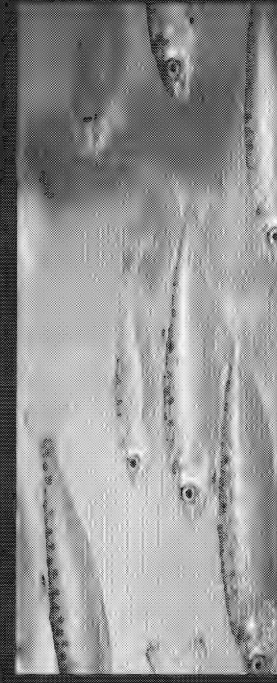
Broad-based assessments of infectious agents provides a clearer picture of the relationships between agents and disease

Diagnostics typically employ agent-specific assays when a specific disease is suspected through pathology or clinical signs, so little information on when agents occur in the absence of disease or roles in co-infection



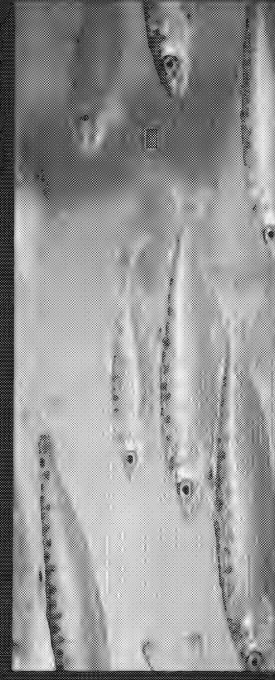
Audit sample analysis reveals that many Infective agents can be present in the absence of the recognizable lesions associated with the diseases they may cause

- 61% of Atlantic salmon and 48% of Chinook salmon with high loads of *Renibacterium salmoninarum* NOT diagnosed with BKD
- 42% of Atlantic salmon and 69% of Chinook salmon with high loads of *Piscirickettsia salmonis* NOT diagnosed with Rickettsiosis
- 65% of Atlantic salmon with high loads of *Tenacibaculum maritimum* NOT diagnosed with Mouth Rot
- 70% of Chinook salmon audits with high PRV loads NOT diagnosed with Jaundice/anemia
- 87% of Atlantic salmon audits with high PRV loads NOT diagnosed with HSMI



Audit sample analysis also reveals that in some cases, infective agents associated with diagnosed diseases were not detected: misdiagnosis, undetected strain-variation, recovery?

- 36% of Atlantic salmon and 2% of Chinook salmon diagnosed with BKD had no *Renibacterium salmoninarum* detected
- 23% of Atlantic salmon and 17% of Chinook salmon diagnosed with Rickettsiosis had no *Piscirickettsia salmonis* detected
- 13% of Atlantic salmon diagnosed with Mouth Rot had no *Tenacibaculum maritimum* detected
- 0% of Chinook salmon audits diagnosed with Jaundice/anemia had no PRV detected
- 3% of Atlantic salmon diagnosed with HSML (viral cardiomyopathy) had no PRV detected



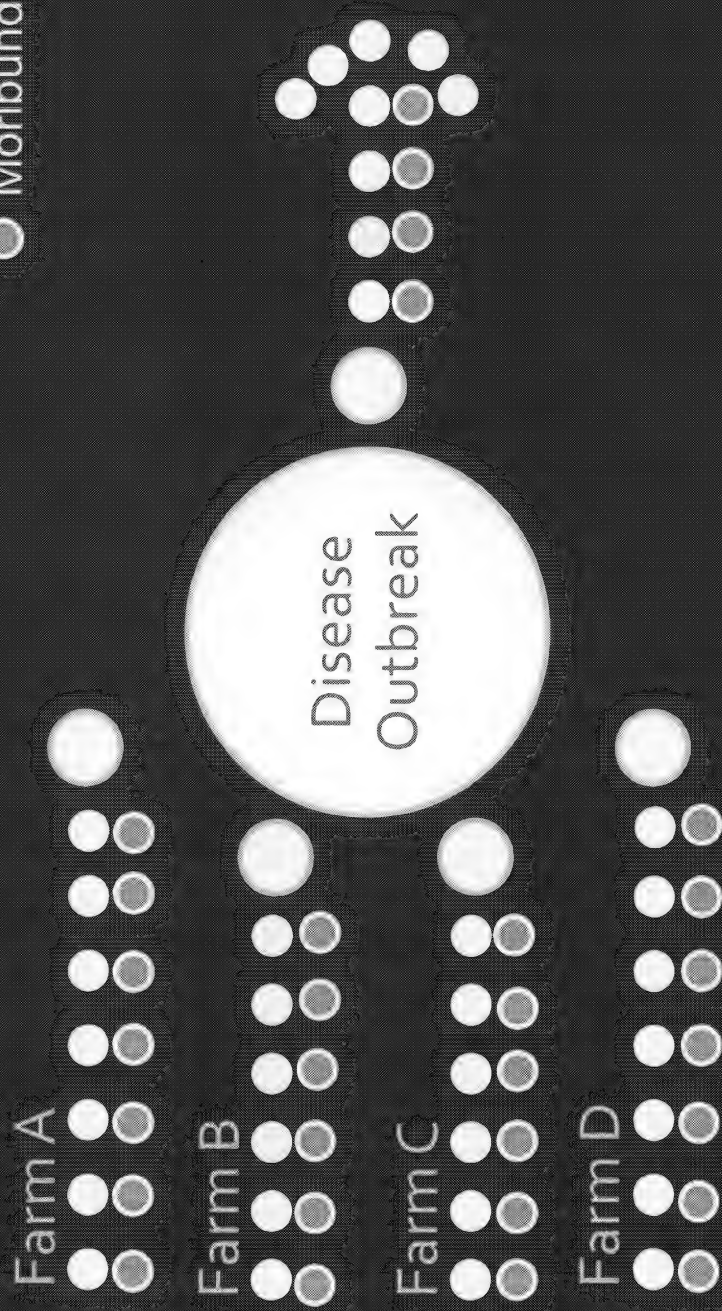
Longitudinal Farm Study Identifies Emerging Salmon Disease



Clinical pathology
Cellular pathology
Molecular profiling
Pathogen monitoring

SSHJ Longitudinal Farm Sampling

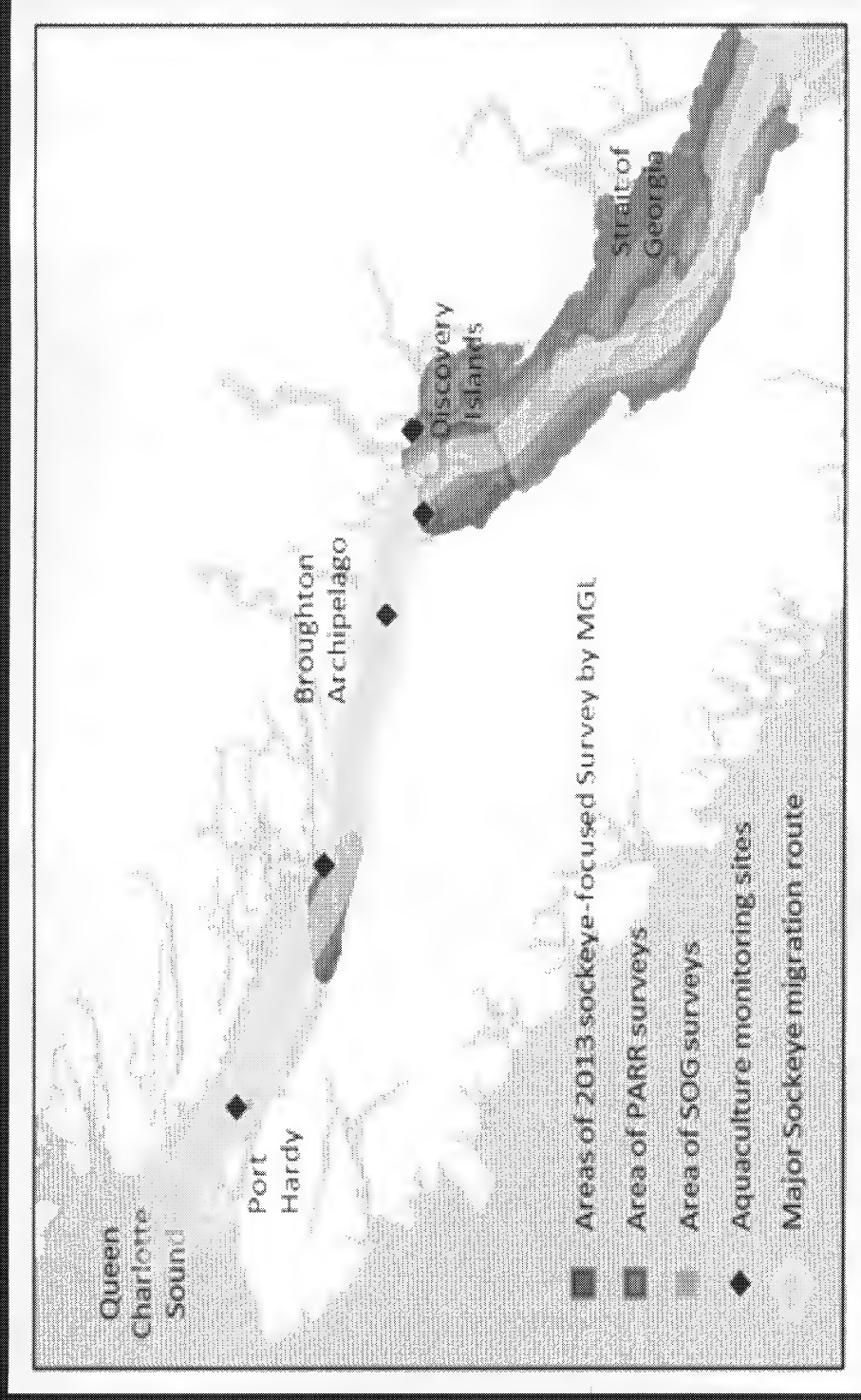
● Live
○ Moribund/dead



Fine-scale temporal sampling to uncover cellular and molecular processes associated with to disease development and recovery

Collection of live fish provides best comparator to samples of migratory salmon

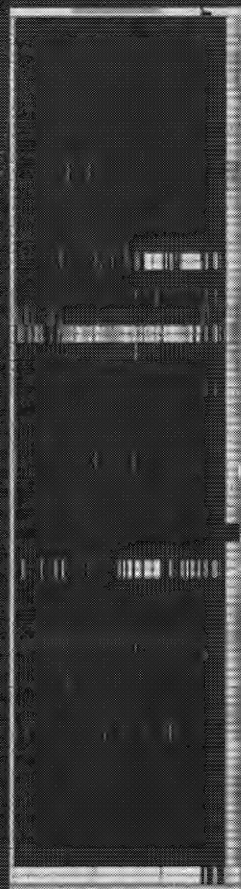
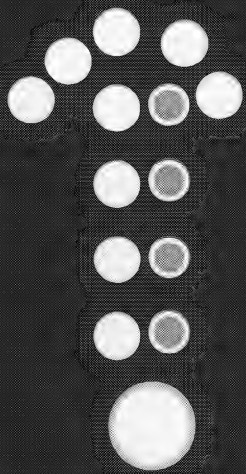
Aquaculture-Wild Interactions



Sampled four geographically dispersed farms over the entire ocean production cycle along the migration pathway of wild salmon emanating from the Fraser River

Longitudinal study resolves full developmental pathway of HSMI

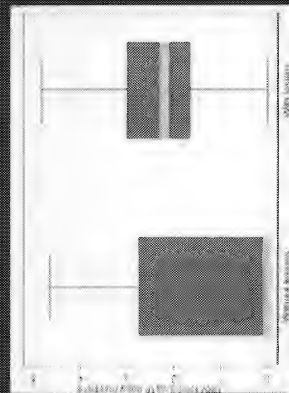
Disease
Outbreak



★ PRV P. ther. Kudoa

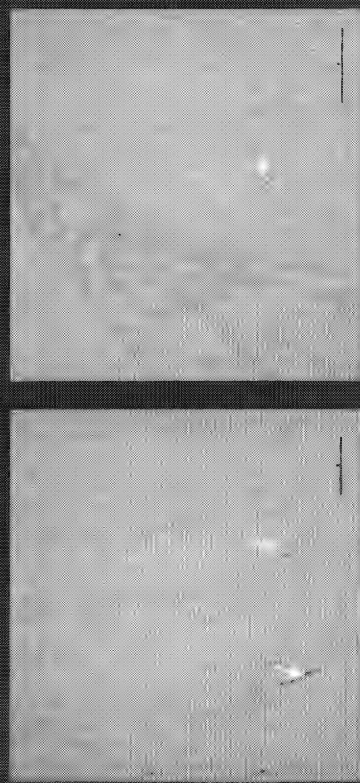
High throughput pathogen monitoring:
Identify the shifting pathogen distributions in the heart

PRV Load



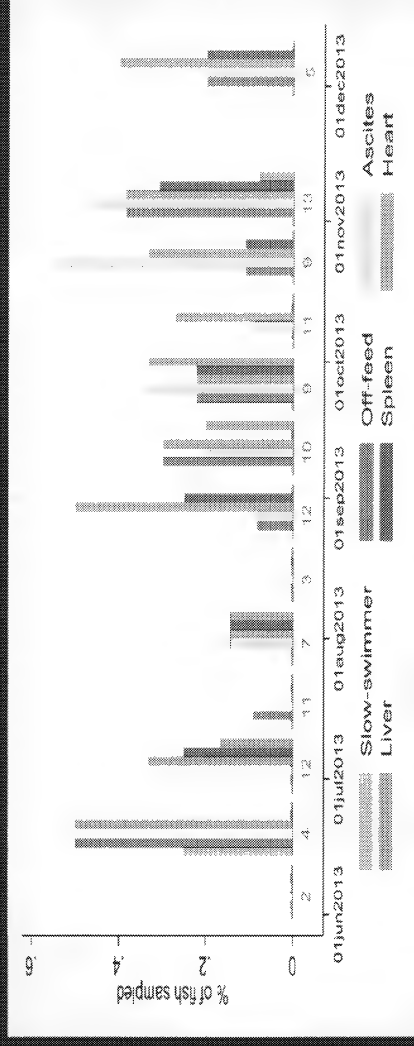
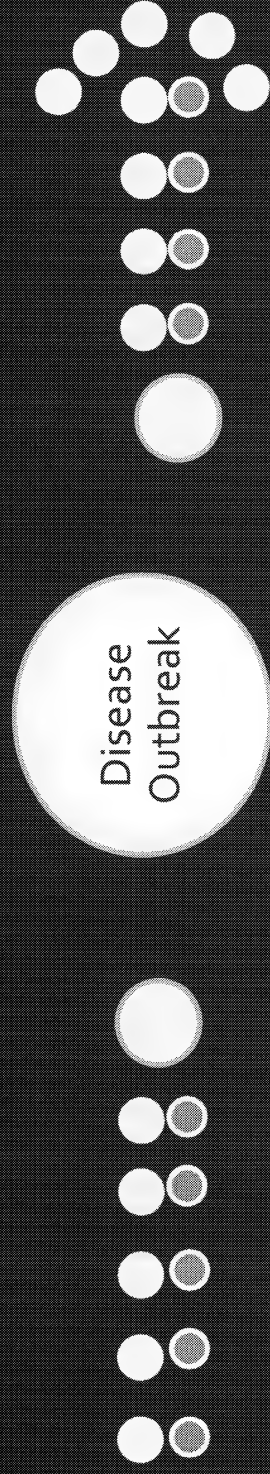
Epidemiological
Analyses:
Identify PRV Pathogen
loads correlated with lesion
scores

No lesions HSMI

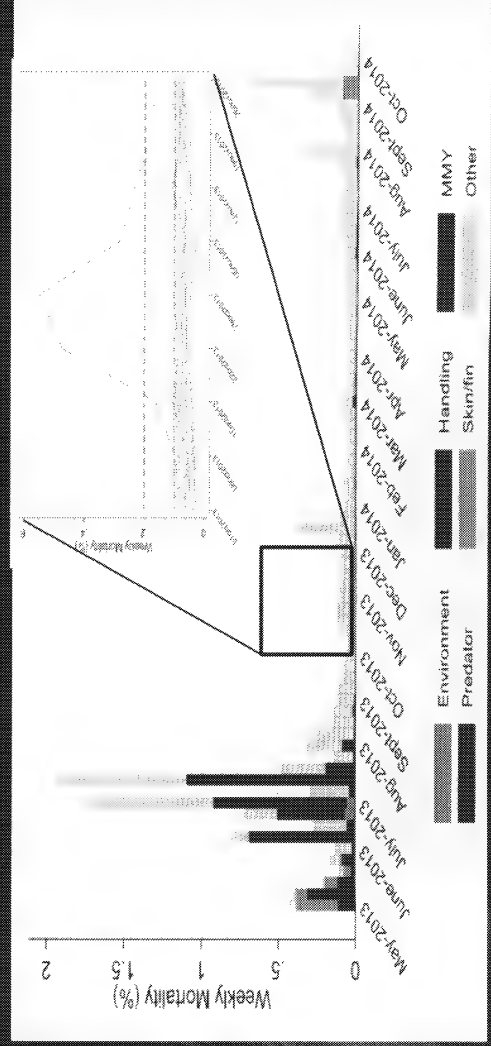


Immunohistochemistry:
Localization of PRV pathogen within the area of tissue damage

Longitudinal study resolves full developmental pathway of HSMI



Clinical data:
Consistent with HSMI outbreaks in Norway



Mortality data:
Minimal impact on survival of fish on the farm

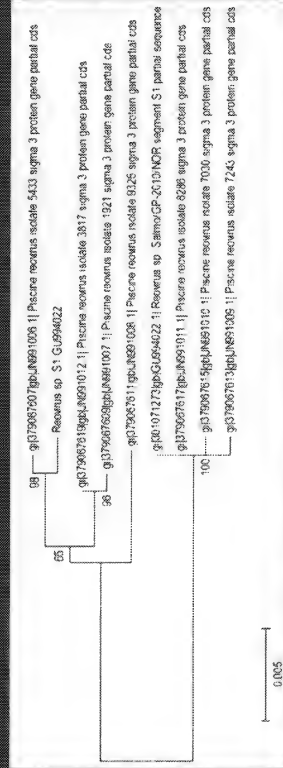
Longitudinal study resolves full developmental pathway of HSM1



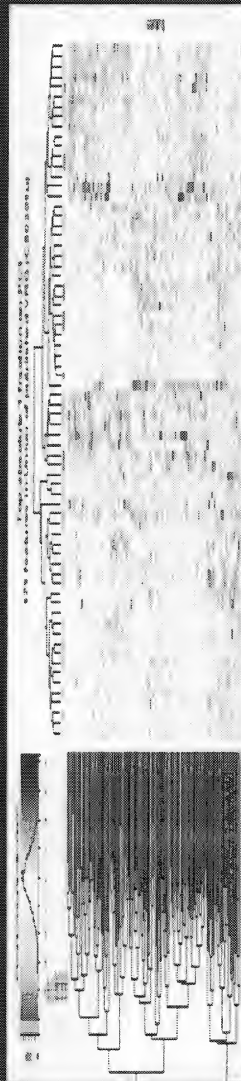
High throughput sequencing:

Full viral genome sequencing identifies PRV strain 99.9% similar to sequences previously observed in wild-migrating BC salmon

Identifying viral transcriptome shifts over disease cycle

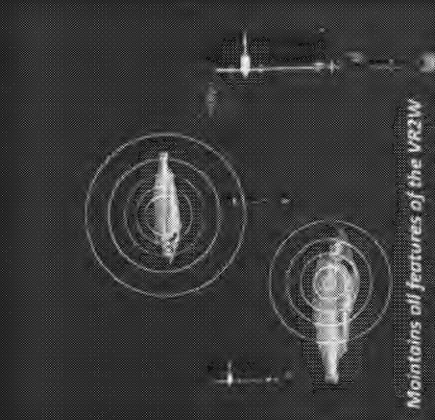


Transcriptomics (RNA-seq) (Underway):
Does the transcriptional profile match HSM1 in Norway?

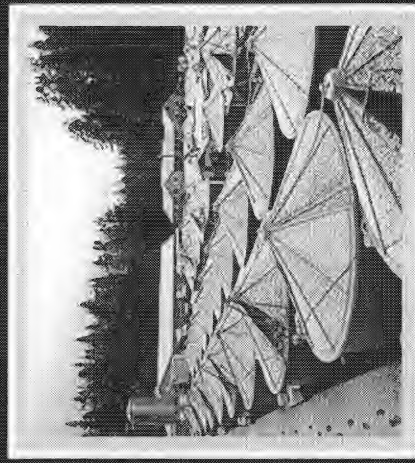


Which infectious agents carried by migratory salmon are actually impacting them?

Establishing Linkages with Survival



Tracking Studies



Holding Studies



Predation Studies

But... linking pathogens with disease in migratory fish is more difficult

Which infectious agents carried by migratory salmon are actually impacting them?

Physiological Impacts

Protein (blood)

Molecular

Cellular

Chinook Smolt Study: Focus on agents showing strong shifts in prevalence/load in the early marine environment

Agents showing strongest physiological impact thus far:
P. minibicornis, C. shasta, PRV, Loma

Novel Viral Disease Diagnostic (VDD) Tool based on host transcriptome

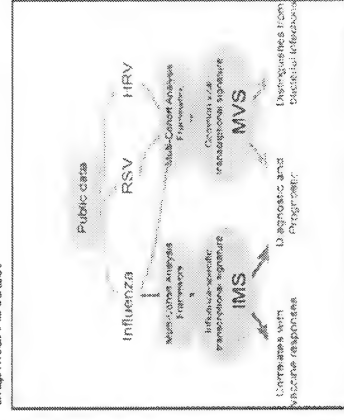


Molecular Disease Diagnostics – human medicine

Immunity

Integrated, Multi-cohort Analysis Identifies Conserved Transcriptional Signatures across Multiple Respiratory Viruses

Graphical Abstract



Authors

Maria Andros-Terra, Helen M. McGuire, Yannick Poudiot, Erika Bongien, Timothy E. Sweetney, Christina M. Tate, Purvesh Khatri

Correspondence

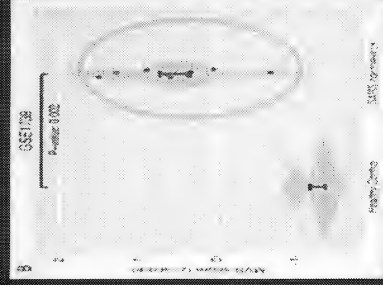
pkhatri@stanford.edu

In Brief

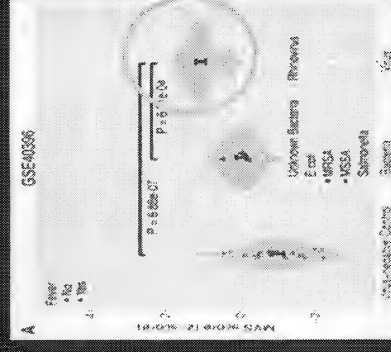
Clinically relevant respiratory viral signatures have not been defined. Khatri and colleagues identified host transcriptional responses common to multiple respiratory viruses (MVS) or specific to influenza (IMS) by leveraging heterogeneity present in public datasets. Both signatures distinguish viral from bacterial infections and IMS also distinguishes influenza from other viral infections.

Andres-Terra et al., 2015, *Immunity* 43, 1199–1211
December 15, 2015 ©2015 Elsevier Inc.
<http://dx.doi.org/10.1016/j.immuni.2015.11.003>

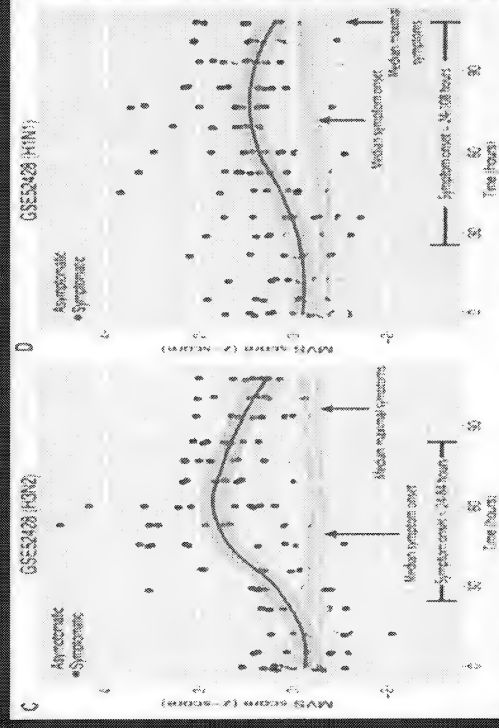
- Mined public transcriptome studies
- Identified diagnostic biomarker signatures for
 - respiratory viral disease
 - specific to influenza virus disease



viral vs. healthy



viral vs. bacterial



Pre-symptomatic viral disease development

Viral Disease Development [VDD] : Salmon RNA viruses

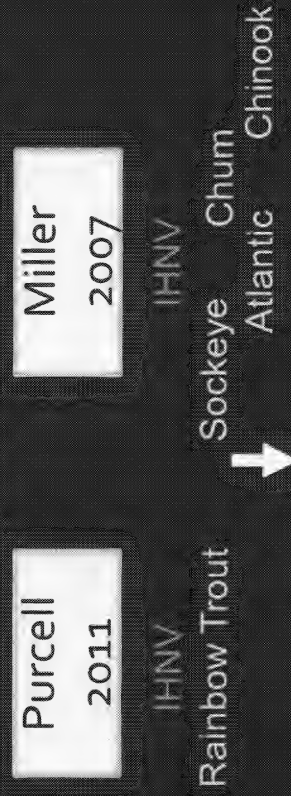
Discovery Analysis—published microarray studies



Published signatures
Union (532 features)

GUNTHER ANALYTICS
Data Analysis, Modeling and Simulation

Exploration Analysis
Gene Shaving, Sparse Independent PCA

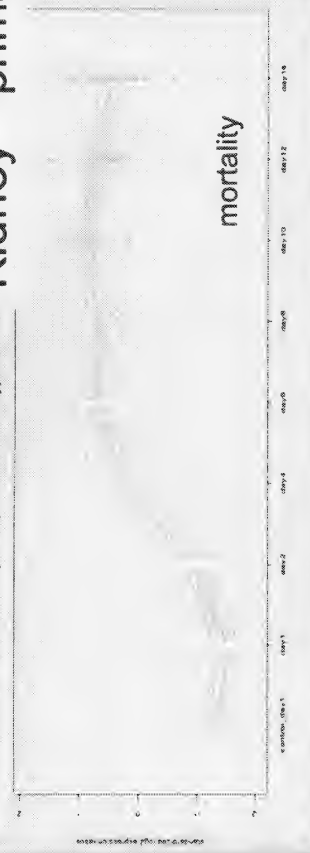


VDD 44 biomarker panel

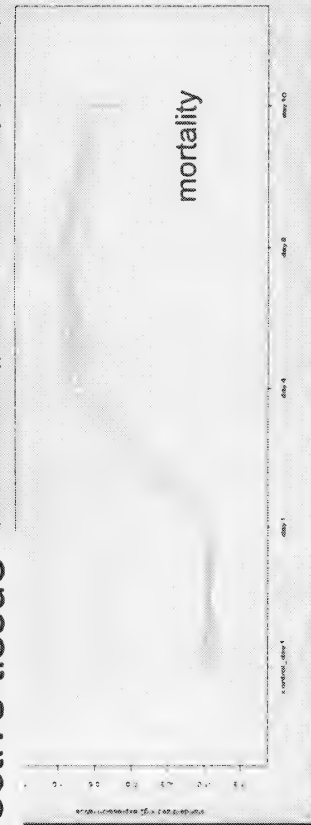
VDD Panel can differentiate IHN diseased Sockeye, Chum, and Atlantic salmon in Experimental Challenge Study

Kidney—primary infective tissue

Time Course Plot for 45 samples (injected-head/kidney) and 39 features



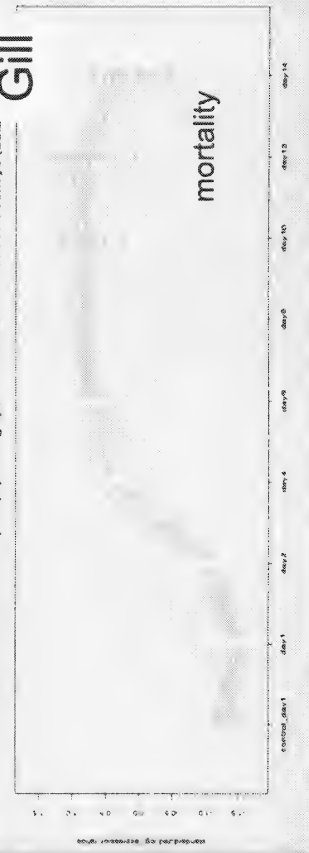
(waterborne-head/kidney) and 39 features from IHNV Sockeye (data scaled)



Time Course Plot for 45 samples (injected-liver) and 39 features from IHNV Sockeye (c



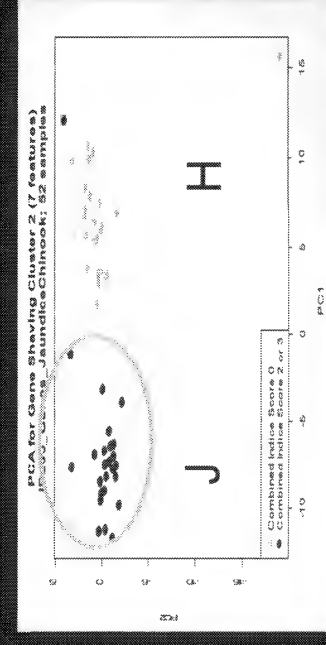
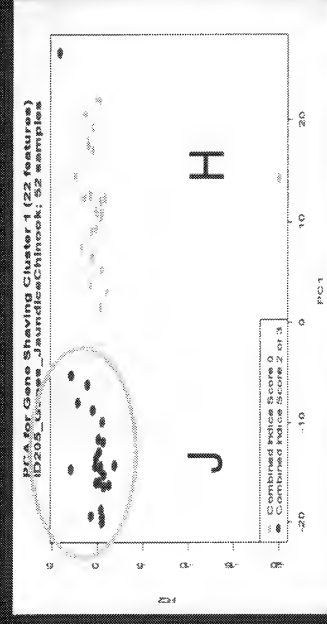
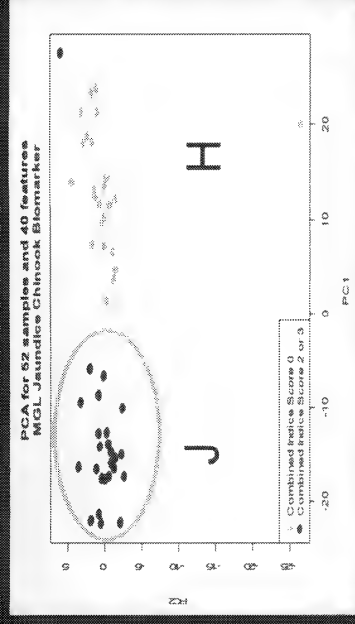
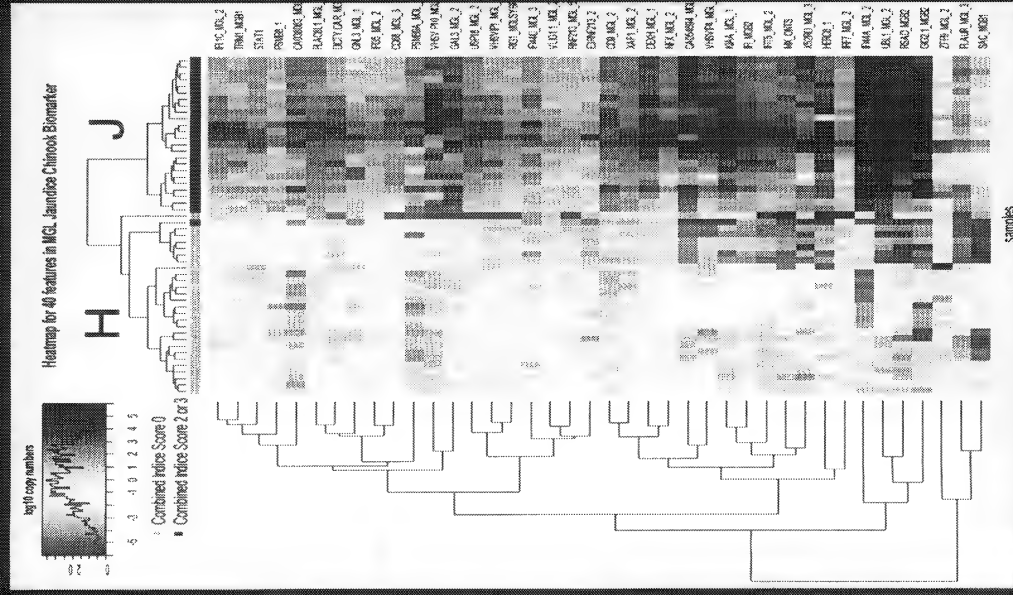
Time Course Plot for 45 samples (injected-gill) and 39 features from IHNV Sockeye (data



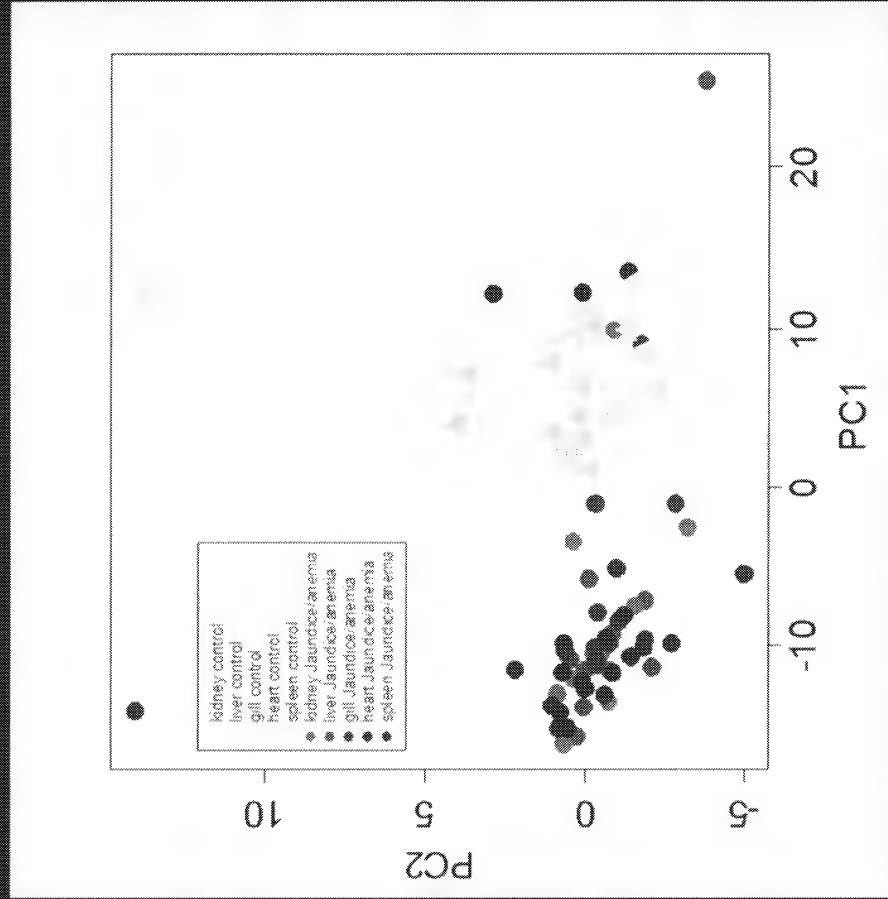
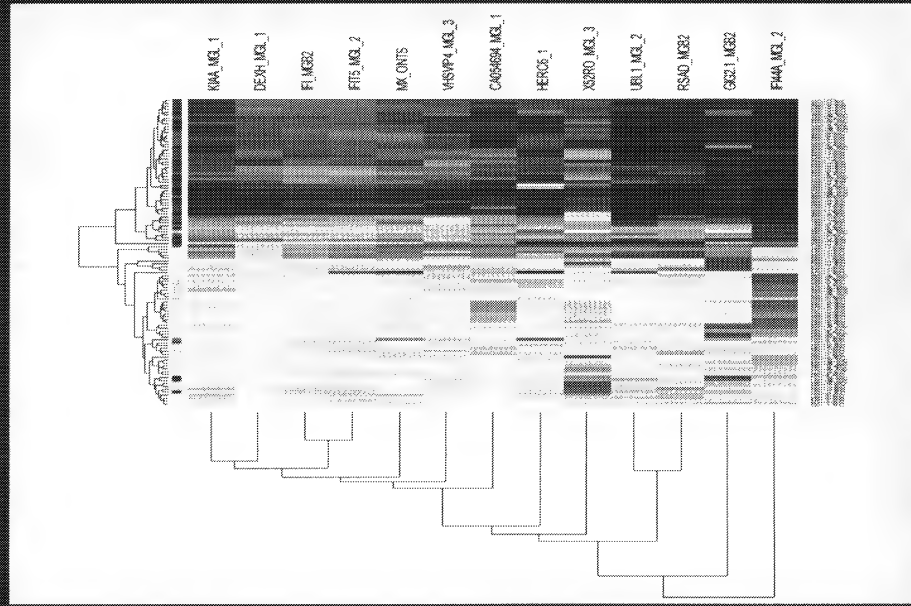
VDD Transcriptional response to IHN identified across species and tissues well before ensuing mortality

Days Post Challenge

VDD Panel can differentiate Jaundice from healthy Chinook salmon
A viral disease not used in VDD discovery

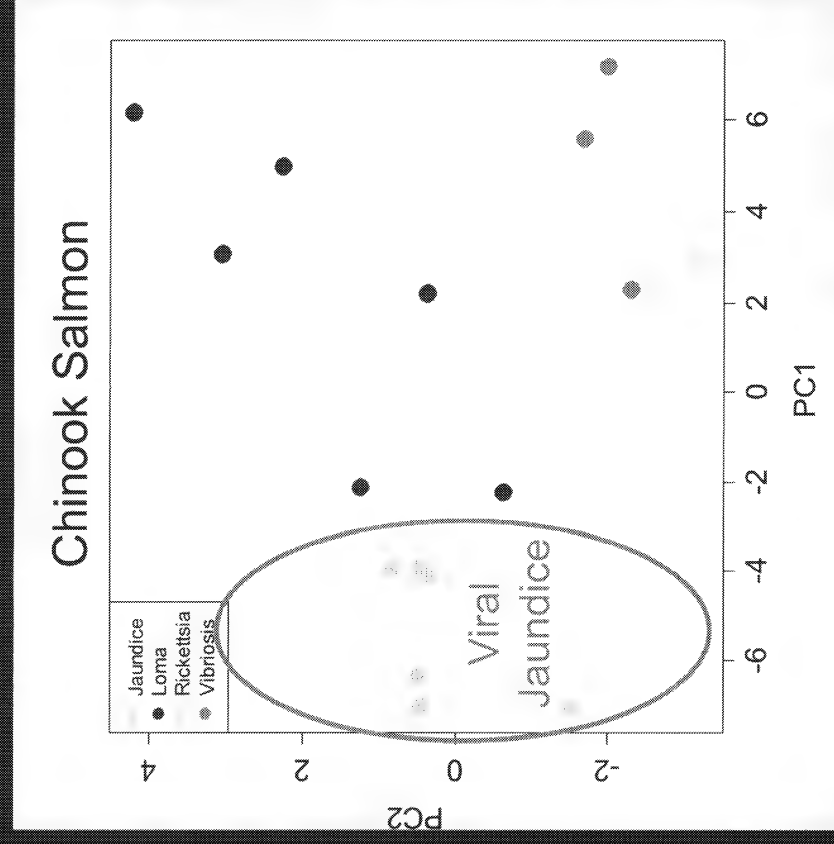
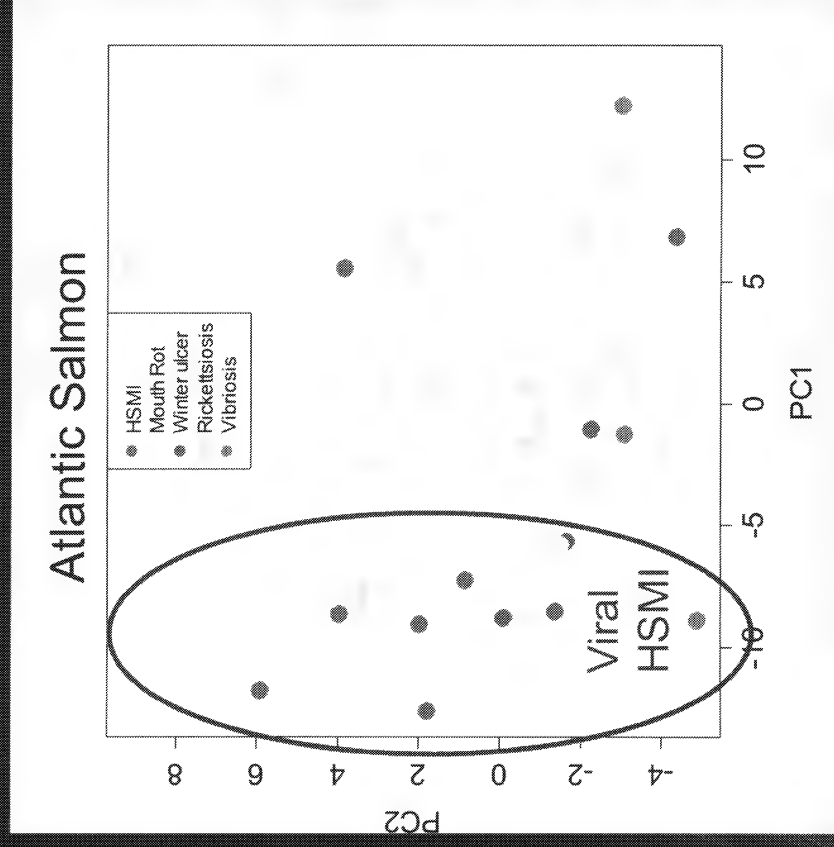


VDD Panel can differentiate Jaundice from healthy Chinook salmon equally across primary and secondary tissues



Molecular biomarkers – early disease detection

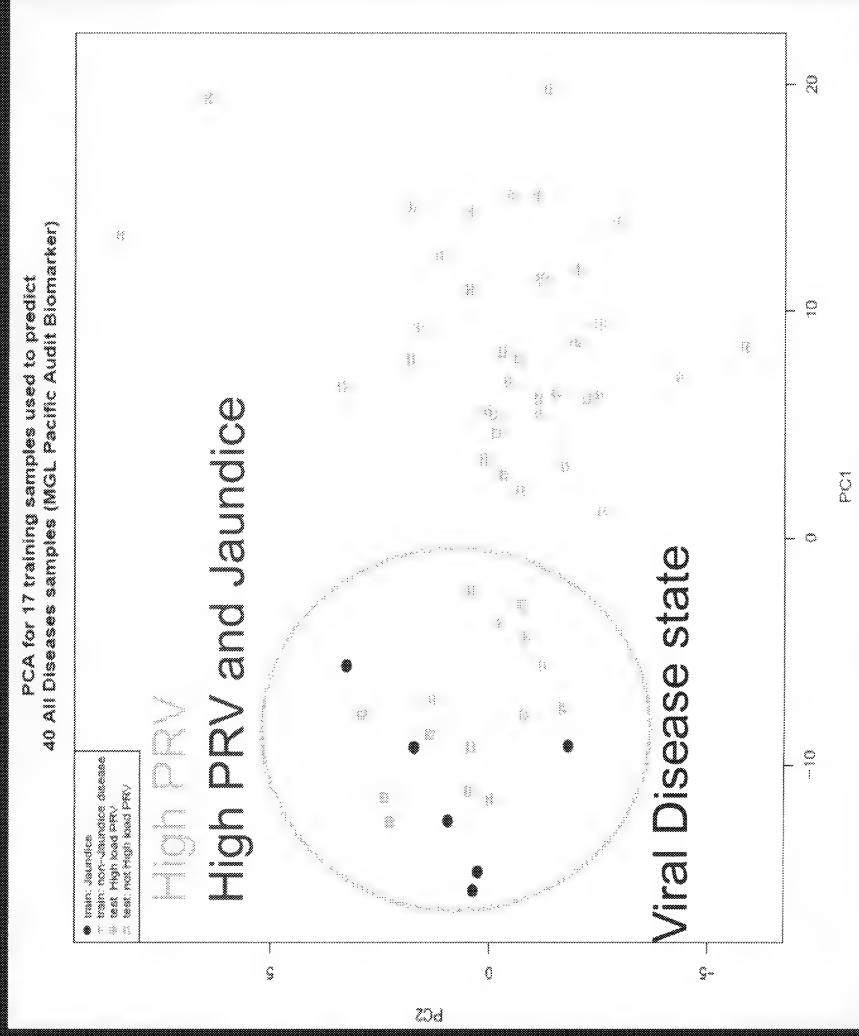
Molecular biomarkers identify differentiate fish with viral versus bacterial diseases



Mixed Tissues, Dead sampled fish,
Diagnosed through Veterinary Pathology

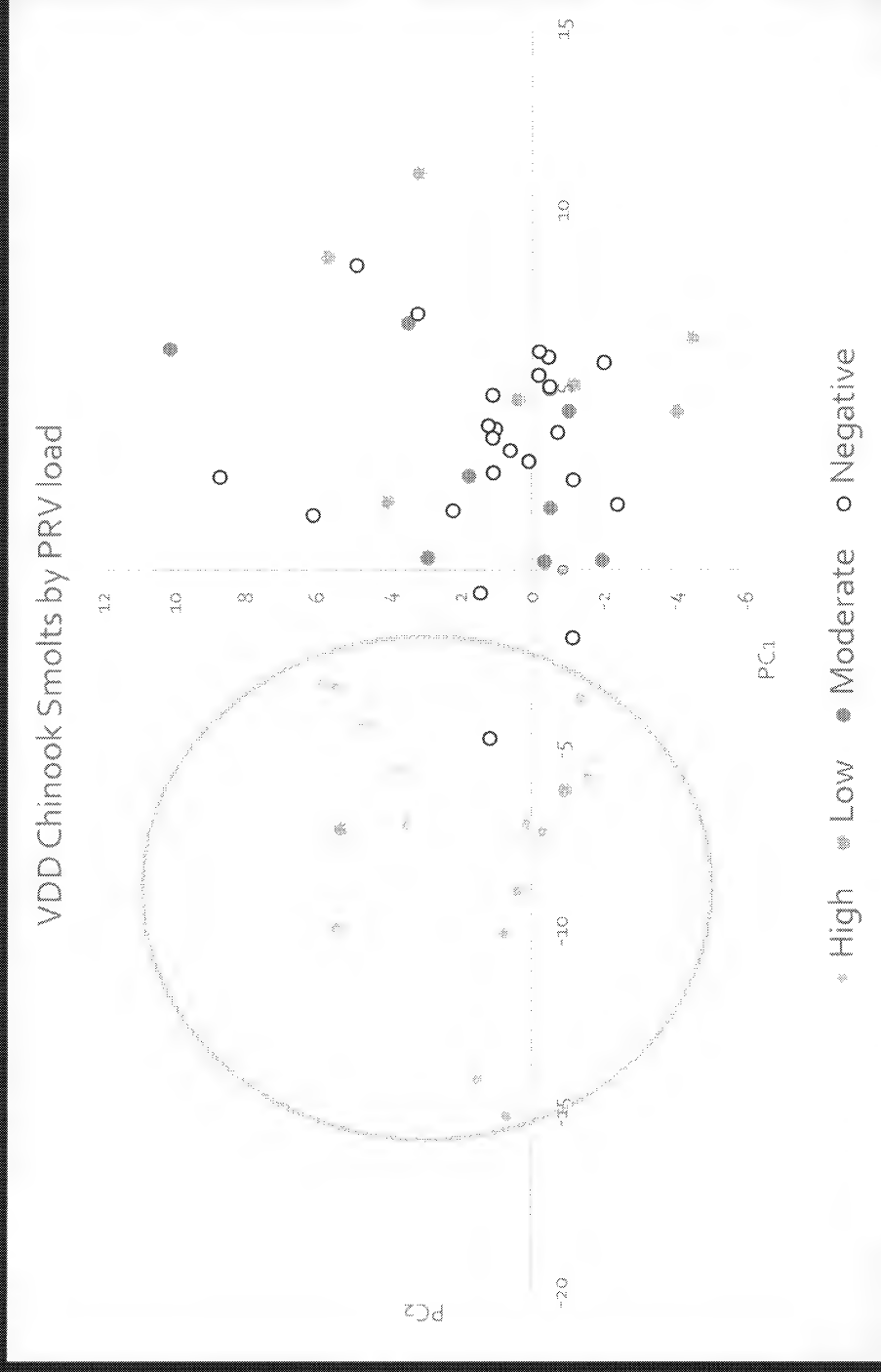
Molecular biomarkers – Piscine Orthoreovirus Farmed Chinook salmon

80% of farmed Chinook salmon with high loads of PRV are in a “viral disease state”



Molecular biomarkers – Piscine Orthoreovirus Wild Chinook Salmon

93% of Wild Chinook juveniles containing high loads of PRV are in a
“viral disease state”



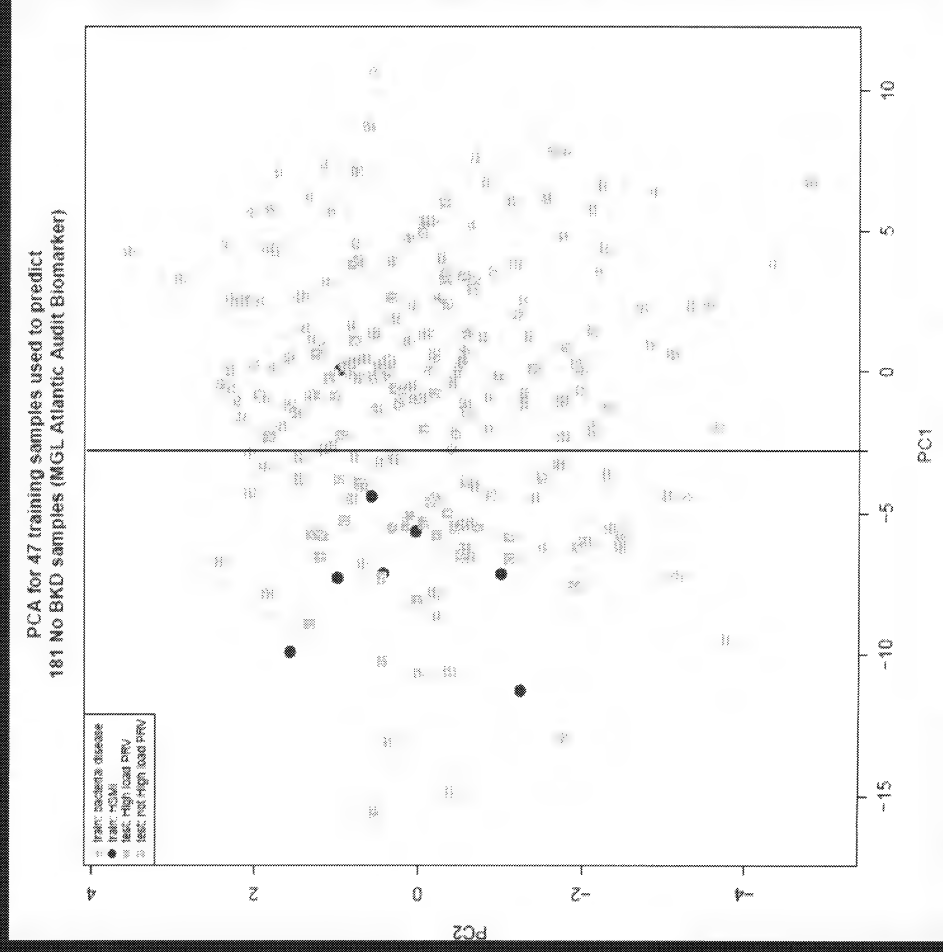
Based on mixed tissue sample

Molecular biomarkers – Piscine Orthoreovirus

Farmed Atlantic salmon

50% of Atlantic salmon containing high loads of PRV are in a “viral disease state”

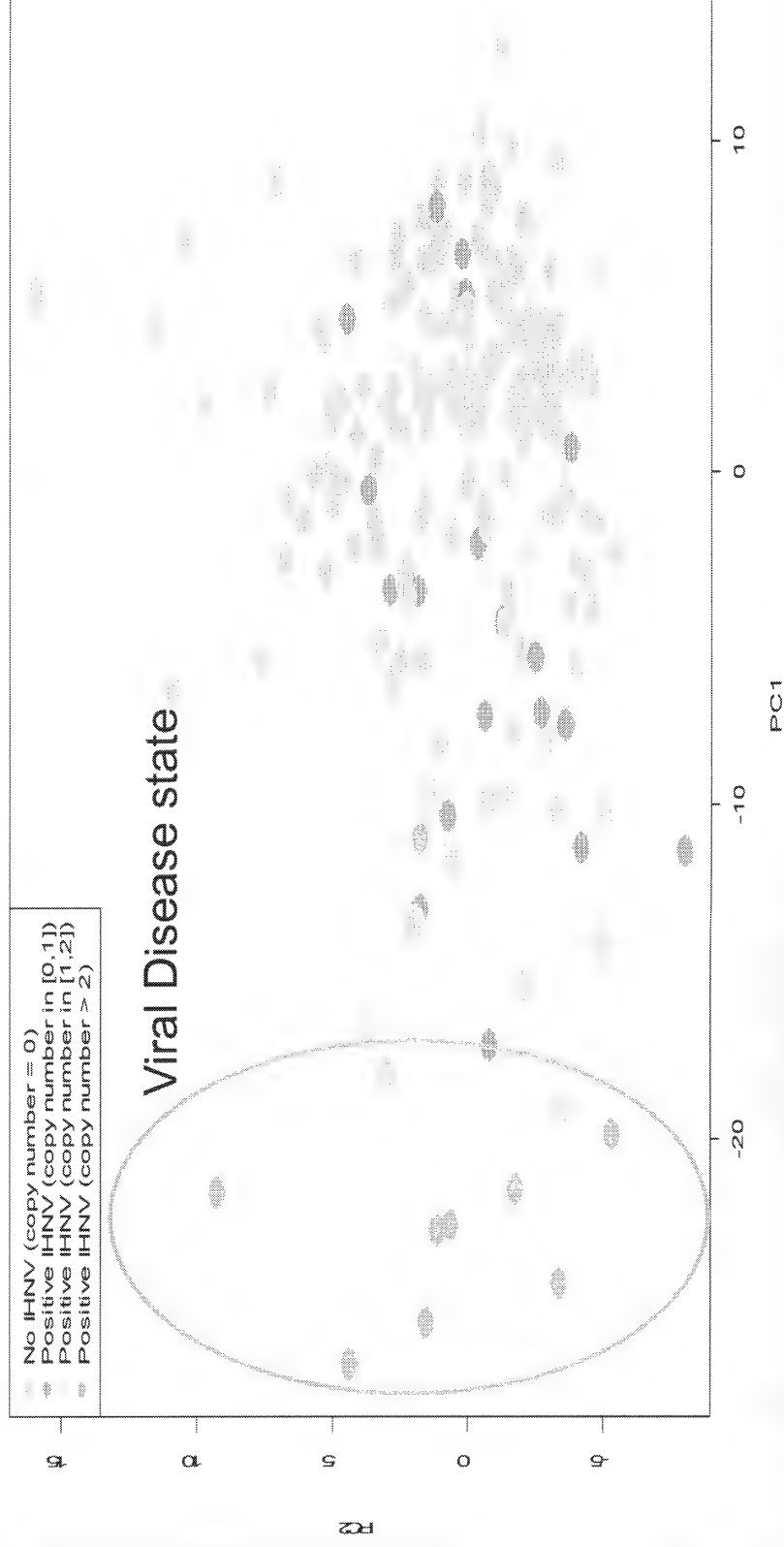
34% of dying Atlantic salmon are in a VDD state—half with unknown viral associations



Wild Chilko Sockeye Smolts with high loads of IHNV in a viral disease state

89% of Wild Chinook juveniles containing high loads of IHNV are in a “viral disease state”

PCA for 236 samples and 39 features (data not scaled)



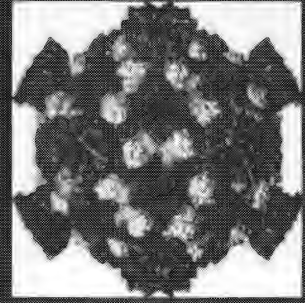
Non-destructive gill biopsies — ideal for application with tracking studies

Objective 3: Sequencing and Phylogenetics

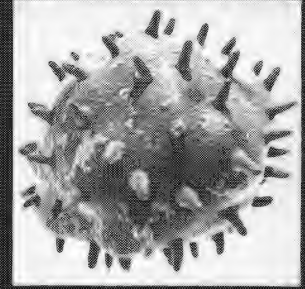
Accomplishments to date:

36 High Throughput Sequencing runs

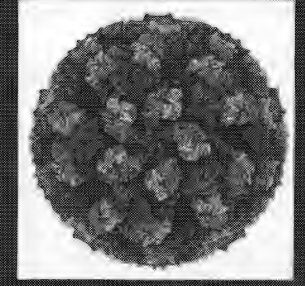
- Agent validation and discovery
- Agent discovery
- PRV/host Transcriptome



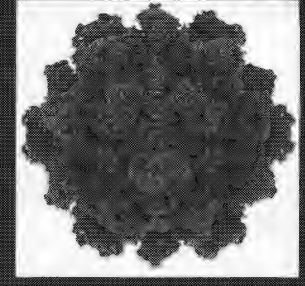
Reovirus



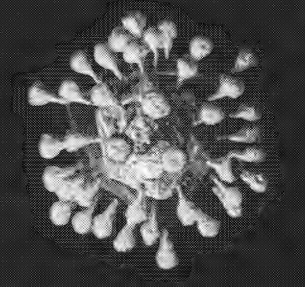
Hepatitis E



Calicivirus

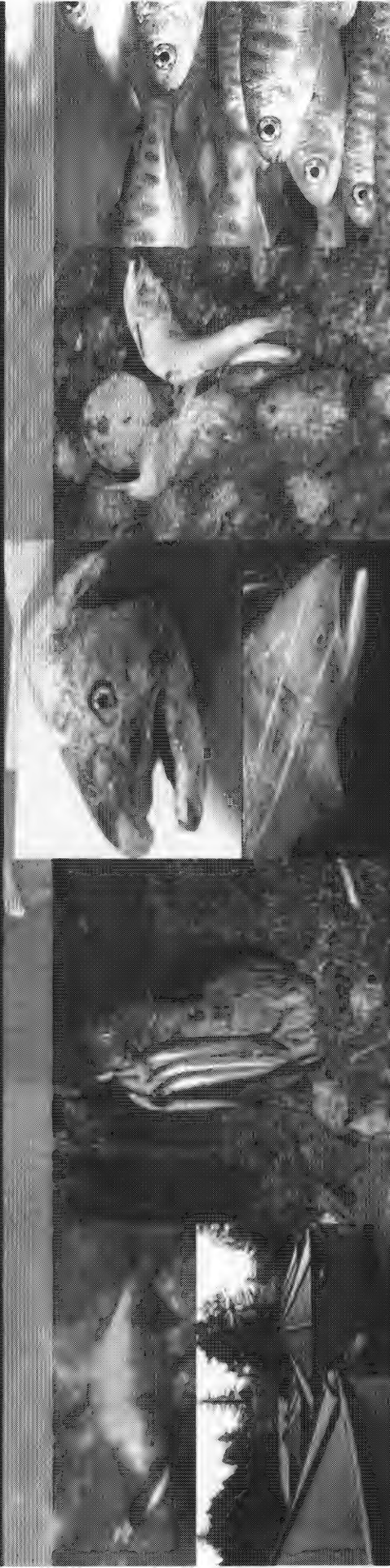


Arenavirus



Coronavirus

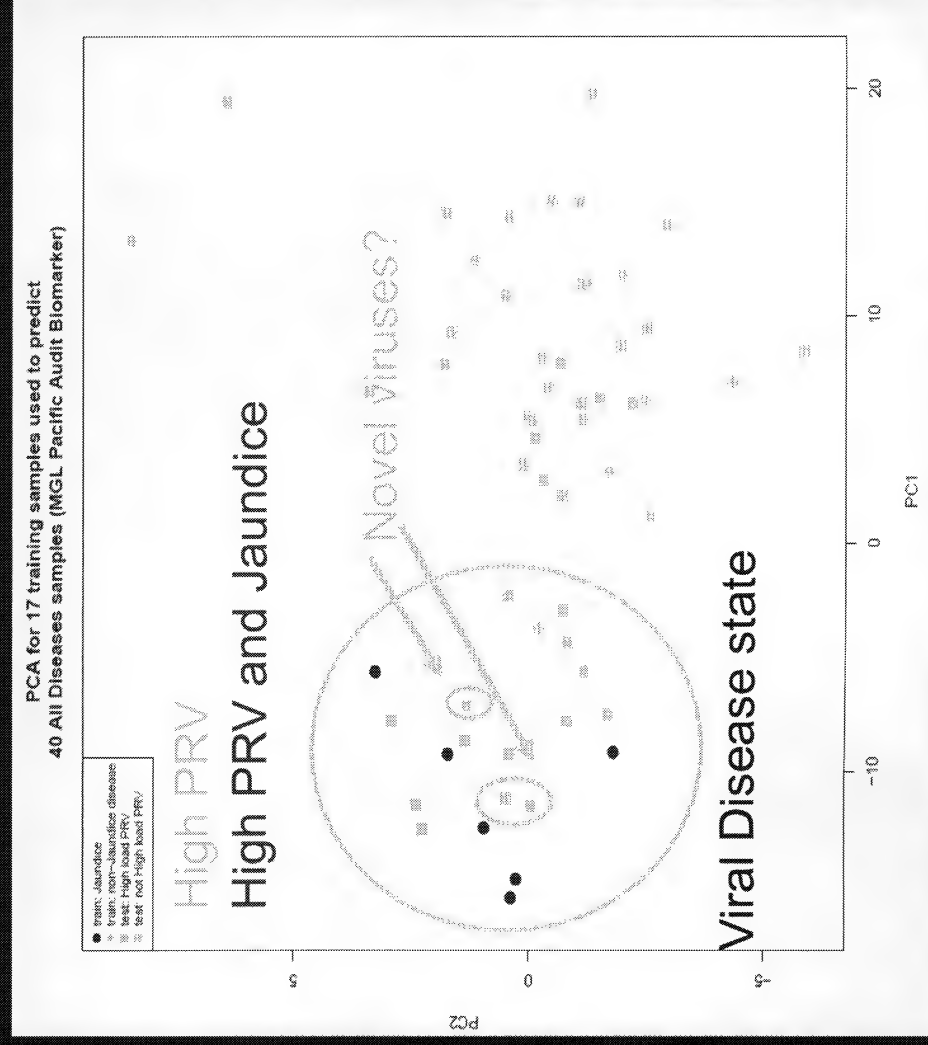
Discovery of Novel Salmon Viruses via Targeted High Throughput Sequencing



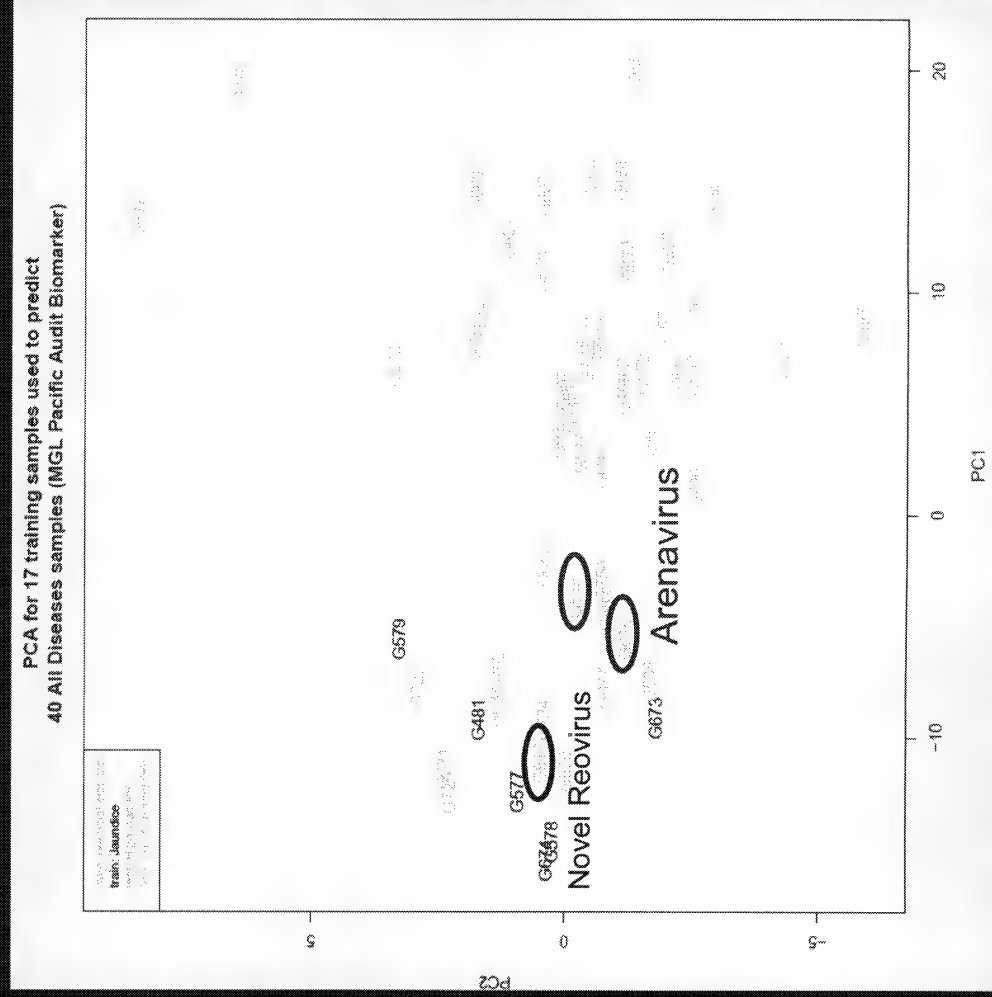
Molecular biomarkers – Piscine Orthoreovirus

Farmed Chinook salmon

VDD Panel can be used to identify fish with uncharacterized viruses associated with a developing disease state



Detection of two novel viruses in farmed Chinook Salmon

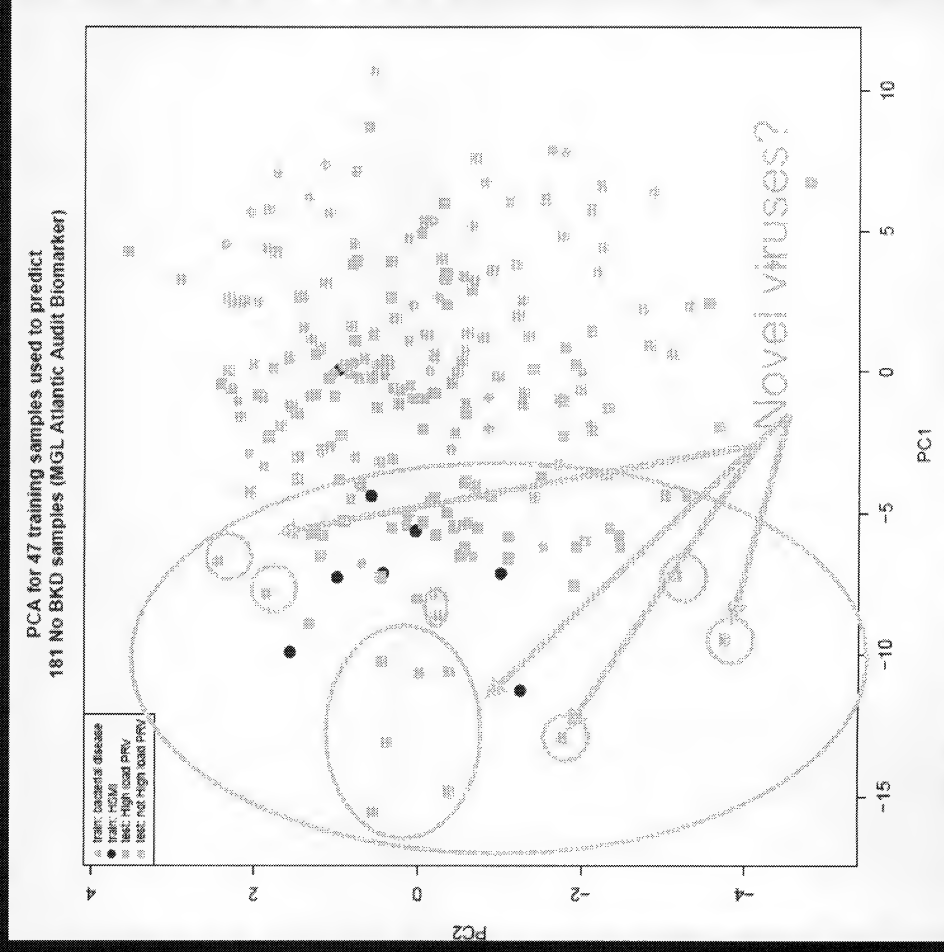


Molecular biomarkers – Piscine Orthoreovirus

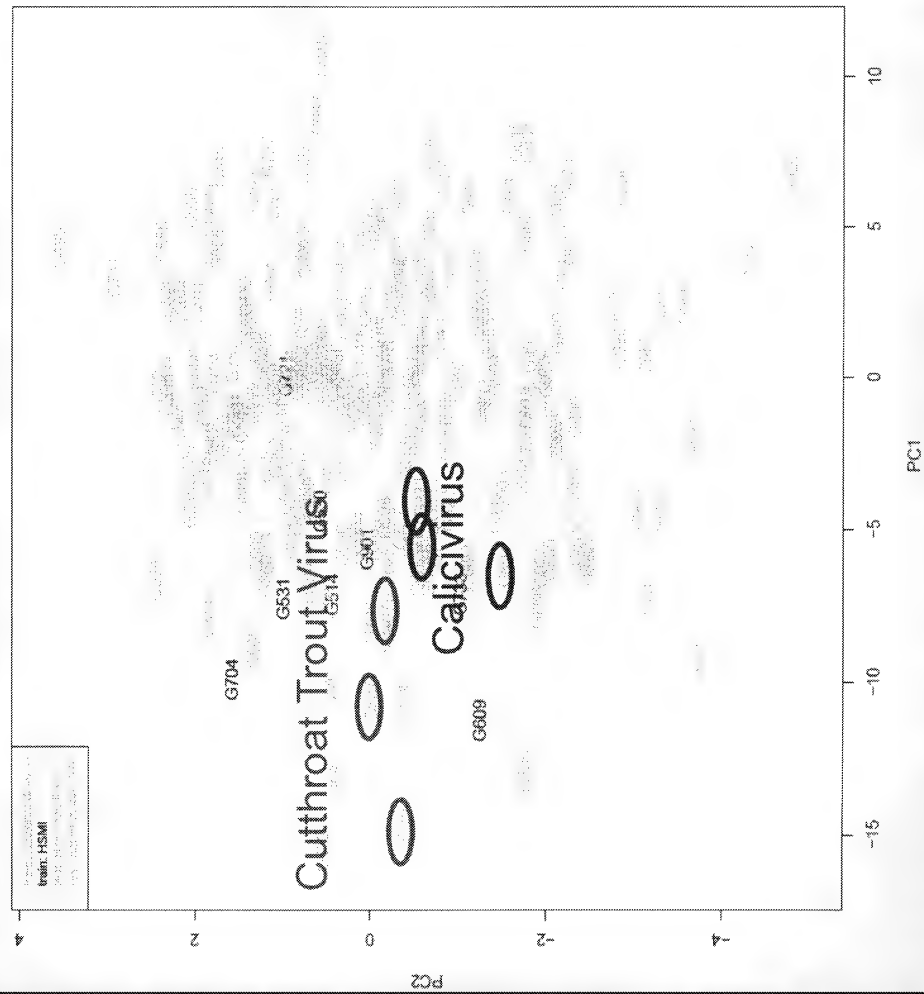
Farmed Atlantic salmon

50% of Atlantic salmon containing high loads of PRV are in a “viral disease state”

34% of dying Atlantic salmon are in a VDD state—half with unknown viral associations



PCA for 47 training samples used to predict
181 No BKD samples (MGL Atlantic Audit Biomarker)



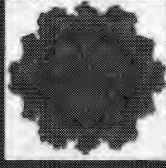
Filling in the Audit data with Four Novel Viruses

- Salmon in a VDD state carry significantly more and higher loads of viruses ($p < 10^6$)
 - Average viral load of $>10,000$ copies/ul compared to <100
 - Identified an RNA virus at high load in 85% of fish in a VDD state
 - $>1/3^{\text{rd}}$ of fish are in a VDD state, and up till now, most of which have not been diagnosed with a specific disease (many lesions of unknown etiology)

Prevalence	Overall	High Load	
PRV	73%	28%	Atlantic/Pacific
Calicivirus	48%	60%	Atlantic
Cutthroat Trout Virus	71%	25%	Atlantic
Arenavirus	5%	33%	Pacific*
Novel Reovirus	6%	25%	Pacific

Preliminary analysis of Lesions in fish with Novel Virus detections (N=146 Audits)

- Arenavirus 23% in Pacific salmon; 4% Atlantic
 - High loads in Chinook only
 - Petechial hemorrhaging on gills, anaemia, brain hemorrhaging



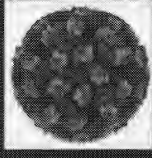
– Novel Reovirus

- 26% in Pacific salmon; 4% Atlantic
- High loads in Chinook only
- Dark spleen, blood filled kidney, anaemia



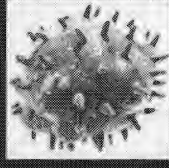
– Atlantic Salmon Calicivirus

- 17% Pacific salmon; 60% Atlantic
- High loads in Atlantic Salmon only
- Systemic inflammatory disease and visceral petechia, some with resemblance to netpen liver disease, brain hemorrhage, branchitis, ascites



– Cutthroat Trout Virus (Hepatitis E)

- novel strain 75% similar to known
- 17% Pacific salmon; 92% Atlantic salmon
- High loads only in Atlantic Salmon only; most with strong VDD
- Pathologist noted for some that pathology resembled IHN

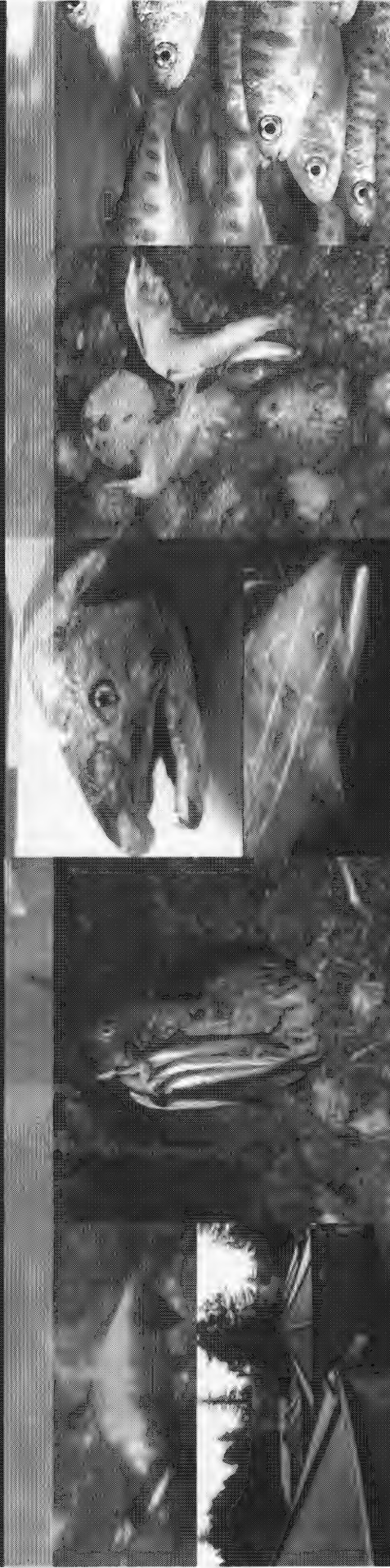


Novel Virus detection in migratory salmon

Chinook smolts migrating in SW (N=343)

- Arenavirus
 - 10.5% prevalence, 14% of which carry high viral loads
 - Highest prevalence Vancouver Island and Thompson River stocks summer/fall
 - Targeted for physiological assessments
- Atlantic Salmon Calicivirus
 - 1.5% prevalence; all high loads
 - Primarily observed in winter/Marble River
 - Targeted for physiological assessments
- Cutthroat Trout Virus (novel strain)
 - Single low load detection
- Novel Reovirus
 - Single high load detection
 - Marble River

Next Steps



Manuscripts in Development

- Audit data: epidemiological descriptions of agents and pathological lesions comparing distributions in Pacific and Atlantic salmon within and among regions (UPEI)
- Network analysis of Audit data (Gunther Analytics)
- Sockeye salmon infectious agent epidemiology (UPEI)
- Infectious agent distributions between hatchery and wild fish (UPEI)
- Novel viruses (UBC)
 - Arenavirus
 - VDD application identifies novel viruses in salmon
- Then and now: agents detected 30 years ago compared to present day in return-migrating sockeye salmon (UPEI)
- Assessing molecular, protein and cellular-level physiological associations with infectious agent profiles (UBC)
- Infectious agent responses to high water temperature stress: Holding studies in Fraser River Sockeye salmon (UBC)
- Selective predation on IHNV infected sockeye salmon smolts (UBC)

Next step research

- RNA-seq study of HSMI development
 - Identification of viral proteins stimulated in association with disease development
 - Host transcriptome: similarities with studies in Norway, independent assessment of VDD activity across a viral disease outbreak
- Establishing linkages between novel viruses and disease
 - Audit sample histopathology, gross lesions, clinical signs, in situ hybridization
 - Chinook salmon multi-level physiology
 - Re-examination of tracking multiple tracking and holding studies
- Complete analyses of farm samples – infectious agents (1600 to go), histopathology, epidemiological analyses
 - Potential to assess farm-level outbreaks of diseases other than HSMI
 - Apply to contrast agent distributions between farmed and migratory salmon (principally sockeye)
- Hatchery-wild assessments of agents
 - Quinsam
 - West Coast of Vancouver Island (Nitinat hatchery)
 - Freshwater natal across sockeye, chinook and coho salmon

Next step research

- In Situ Hybridization studies
 - Localizing poorly characterized agents to regions of tissue damage
 - Exploring co-infections
 - Further exploring PRV-HSMI and PRV-Jaundice disease associations
- eDNA: Detection of infectious agents in the water column
 - Collaboration with Norway
 - Preliminary study underway merging infectious agent and marine fish detections
- Moving towards challenge studies
 - Help establish challenge facility at VIU
 - Physiological performance end point rather than primary focus on mortality
 - Attempt to culture novel viruses
 - PRV and novel virus currently of highest interest
 - Strong focus of Phase 3 research

Miller-Saunders, Kristi

From: Taylor, Nathan
Sent: November-08-17 7:55 AM
To: Miller-Saunders, Kristi
Subject: RE: Creative salmon

Thnx. Will let you know I hear of anything.

-----Original Message-----

From: Miller-Saunders, Kristi
Sent: Wednesday, November 08, 2017 7:54 AM
To: Taylor, Nathan
Subject: Creative salmon

Just an fyi
Kristi

s.21(1)(a)

s.21(1)(b)

Miller-Saunders, Kristi

From: Miller-Saunders, Kristi
Sent: November-08-17 9:25 AM
To: Brian Riddell
Subject: FW: review of manuscript
Attachments: Jaundice study manuscript Supplemental Tables and Figure_V2.docx; Jaundice study Manuscript_Sept 2017 Revision_clean_V2.docx

FYI

From: [REDACTED] - Creative Salmon [REDACTED]
Sent: November-08-17 8:11 AM
To: Miller-Saunders, Kristi; Taylor, Nathan; Marty, Gary D AGRI:EX; [REDACTED]
Cc: [REDACTED] - Creative Salmon
Subject: RE: review of manuscript

Hi Dr. Miller-Saunders,

I can assure you that there is no intent at delay now (nor was there when we were working on this last time).

Multiple calls to discuss a 3 year old manuscript is not to be unexpected.

The degree of financial hardship for the industry or lack there of is not a factor in any of this. I might remind you that Creative Salmon initiated the request for the study in the first place to try to understand why we were seeing a small amount of jaundiced fish.

I can't speak to Gary's or [REDACTED] views on PRV or HSMI.

[REDACTED]

The manuscript has sat for 3 years, and was shelved by you, and I really appreciate you dusting it off and working on it again. I truly understand the frustration of the constant back and forth on this, then and now, and truthfully would like nothing better then to have this finished, but the reason for the back and forth last time hasn't disappeared because you resurrected the manuscript. There is still some fundamental disagreement on the discussion between co-authors. This has been further compounded by the use of the data from this manuscript and your discussion, in the 2017 paper. (without any of the co-authors knowledge or permission).

Creative Salmon is really in the middle of this, and reliant on scientists and vets for interpretation, and I'm really not sure what we do if the main co-authors disagree. (ie we are not some type of tie breaker) This has never happened to us before in the 25+ years of research we have participated in.

I really think we need some 3rd party scientific mediation (does this exist?) that can bring everyone together, and / or have the two interpretations represented in the manuscript.

I will discuss with the other co-authors about getting you the review we've done to date to continue this moving forward, but I really think its going to bring further frustration, and there is not agreement on publishing the manuscript until we can somehow resolve the difference in opinions.

Open to suggestions on a path forward.

Thanks,

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From: Miller-Saunders, Kristi [mailto:Kristi.Saunders@dfo-mpo.gc.ca]
Sent: Tuesday, November 07, 2017 7:32 PM
To: [REDACTED] Creative Salmon; Taylor, Nathan
Cc: [REDACTED] - Creative Salmon
Subject: RE: review of manuscript

[REDACTED]
This does not work for me and is appearing to be very similar to past patterns of delay. I have heard nothing from either Gary or [REDACTED] so I am not clear on their intent.

I am really not sure what should take multiple calls when the only substantive changes to the manuscript were the inclusion of recent publications that added context to our findings. We spent almost 3 years going through this study previously. [REDACTED]

[REDACTED] I recognize that perhaps HSMI and jaundice are not causing such financial hardship to the industry that you deem it important enough to fully resolve, but our research beyond this study is suggestive of a consistent role of PRV in the development of both of these diseases. I have not overly played this role in the manuscript, although I do present briefly the recent studies linking PRV to jaundice in Pacific salmon in Norway, Chile, and Japan.

[REDACTED]
I too have a very busy schedule and will be away much of December, and I have every intent to get this paper submitted before I go away.

Kristi

From: [REDACTED] - Creative Salmon [REDACTED]
Sent: November 6, 2017 7:46 AM
To: Miller-Saunders, Kristi; Taylor, Nathan
Cc: [REDACTED] - Creative Salmon
Subject: RE: review of manuscript

s.19(1)

s.21(1)(b)

Hi Dr. Miller-Saunders,

I'm sorry, we unfortunately will not have the review of the manuscript completed by this week.



As mentioned, it's a very busy time for everyone. Our next call to discuss this will be in the week of Nov 20th, and hope to get back to you shortly after that.

Best Regards,





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From: Miller-Saunders, Kristi [<mailto:Kristi.Saunders@dfo-mpo.gc.ca>]
Sent: Monday, October 30, 2017 2:29 PM
To:  Creative Salmon; Taylor, Nathan
Cc:  - Creative Salmon
Subject: FW: review of manuscript

I accidentally did not press reply all.
Kristi

From: Miller-Saunders, Kristi
Sent: October-30-17 2:29 PM
To:  - Creative Salmon
Subject: RE: review of manuscript

Thank you for getting back to me  At this point, I would not expect extensive edits to the intro, methods, or results, as we have hashed these out extensively in the past and nothing substantive has changed, and I have incorporated almost all of the suggestions from previous comments. In answer to your question, yes, we re-analysed all of your samples with our full agent panel, after the validation of the platform, and using the same methods we have applied on over 16,000 samples to date.

I would appreciate your getting your comments back by next Wed.

Thanks,

s.19(1)

Kristi

From: [REDACTED] - Creative Salmon [REDACTED]
Sent: October-30-17 2:14 PM
To: Miller-Saunders, Kristi; [REDACTED] - Creative Salmon
Cc: Taylor, Nathan
Subject: review of manuscript

Hi Dr. Miller,

We just wanted to touch base to let you know that we have been working on our review of the jaundice study manuscript and had hoped to get you comments/edits by the end of this month but unfortunately we will need a few additional days. We have had a couple of calls already and have another scheduled for Friday morning to review and discuss our edits and can hopefully get you the reviewed draft early next week.

We do have a question, were the samples from the study re-analyzed with your system since once it had been validated?

Regards,

[REDACTED]

[REDACTED]

Creative Salmon Co. Ltd.

T [REDACTED]

F 250-725-2885

C [REDACTED]

creativesalmon.com



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s.19(1)

Supplemental Table 1. TaqMan assay references for infectious agents assessed on the Fluidigm BioMark™ HD platform. See Miller et al. 2015 for full references and TaqMan assay details.

Infectious Agent	Type	Assay Abbreviation	Assay Reference
<i>Aeromonas hydrophila</i>	Bacterium	ae_hyd	Lee <i>et al.</i> 2006
<i>Aeromonas salmonicida</i>	Bacterium	ae_sal	modified from Keeling <i>et al.</i> 2013
<i>Candidatus Branchiomonas cysticola</i>	Bacterium	c_b_cys	Mitchell <i>et al.</i> 2013
<i>Flavobacterium psychrophilum</i>	Bacterium	fl_psy	Duesund <i>et al.</i> 2010
<i>Gill chlamydia</i>	Bacterium	sch	Duesund <i>et al.</i> 2010
<i>Piscichlamydia salmonis</i>	Bacterium	pch_sal	Nylund <i>et al.</i> 2008
<i>Piscirickettsia salmonis</i>	Bacterium	pisck_sal	Corbeil <i>et al.</i> 2003
<i>Renibacterium salmoninarum</i>	Bacterium	re_sal	Powell <i>et al.</i> 2005
<i>Rickettsia</i> -like organism	Bacterium	rlo	Lloyd <i>et al.</i> 2011
<i>Vibrio anguillarum</i>	Bacterium	vi_ang	Miller <i>et al.</i> 2015
<i>Vibrio salmonicida</i>	Bacterium	vi_sal	Miller <i>et al.</i> 2015
<i>Nanophyetus salmincola</i>	Fluke	na_sal	Miller <i>et al.</i> 2015
<i>Ceratomyxa shasta</i>	Parasite	ce_sha	Hallett and Bartholomew 2006
<i>Cryptobia salmositica</i>	Parasite	cr_sal	Miller <i>et al.</i> 2015
<i>Dermocystidium salmonis</i>	Parasite	de_sal	Miller <i>et al.</i> 2015
<i>Facilispora margolisi</i>	Parasite	fa_mar	Miller <i>et al.</i> 2015
<i>Gyrodactylus salaris</i>	Parasite	gy_sal	Collins <i>et al.</i> 2010
<i>Ichthyophonus hoferi</i>	Parasite	ic_hof	White <i>et al.</i> 2013
<i>Ichthyophthirius multifiliis</i>	Parasite	ic_mul	Miller <i>et al.</i> 2015
<i>Kudoa thyrsites</i>	Parasite	ku_thy	Funk <i>et al.</i> 2007
<i>Loma</i> sp.	Parasite	lo_sal	Miller <i>et al.</i> 2015
<i>Myxobolus arcticus</i>	Parasite	my_arc	Miller <i>et al.</i> 2015
<i>Myxobolus cerebrialis</i>	Parasite	my_cer	Kelley <i>et al.</i> 2004
<i>Myxobolus insidiosus</i>	Parasite	my_ins	Miller <i>et al.</i> 2015
<i>Neoparamoeba perurans</i>	Parasite	ne_per	Fringuelli <i>et al.</i> 2012
<i>Nucleospora salmonis</i>	Parasite	nu_sal	Foltz <i>et al.</i> 2009
<i>Paranucleospora theridion</i>	Parasite	pa_ther	Nylund <i>et al.</i> 2010
<i>Parvicapsula kabatai</i>	Parasite	pa_kab	Miller <i>et al.</i> 2015
<i>Parvicapsula minibicornis</i>	Parasite	pa_min	Hallett and Bartholomew 2009
<i>Parvicapsula pseudobranchicola</i>	Parasite	pa_pse	Jørgensen <i>et al.</i> 2011
<i>Sphaerothecum destructuens</i>	Parasite	sp_des	Miller <i>et al.</i> 2015
<i>Spironucleus salmonicida</i>	Parasite	sp_sal	Miller <i>et al.</i> 2015
<i>Tetracapsuloides bryosalmonae</i>	Parasite	te_bry	Bettge <i>et al.</i> 2009
Atlantic salmon paramyxovirus	Virus	aspv	Nylund <i>et al.</i> 2008
Infectious hematopoietic necrosis virus	Virus	ihnv	Purcell <i>et al.</i> 2013
Infectious pancreatic necrosis virus	Virus	ipnv	Clouthier <i>et al.</i> 2014
Infectious salmon anemia virus	Virus	Snow7	Snow <i>et al.</i> 2006
Infectious salmon anemia virus	Virus	isav8	LeBlanc <i>et al.</i> 2010
Pacific salmon parvovirus	Virus	pspv	Miller <i>et al.</i> 2015
Piscine myocarditis virus (CMS)	Virus	pmcv1	Wiik-Nielsen <i>et al.</i> 2013
Piscine reovirus (HSMI)	Virus	prv	Wiik-Nielsen <i>et al.</i> 2012
Salmon alphavirus 1, 2, and 3	Virus	sav	Andersen <i>et al.</i> 2007
Salmonid herpesvirus / <i>Oncorhynchus</i>	Virus	omv	Miller <i>et al.</i> 2015
Viral encephalopathy and retinopathy	Virus	ver	Korsnes <i>et al.</i> 2005
Erythrocytic necrosis virus	Virus	env	Purcell <i>et al.</i> 2016
Viral hemorrhagic septicemia virus	Virus	vhsv1	Jonstrup <i>et al.</i> 2013
Si:dkey-78d16.1 protein [<i>Danio rerio</i>]	Housekeeping	hkg	Miller <i>et al.</i> 2015

Supplemental Table 2. Stocking information for farms A and B.

Farm A	Farm B
May, 2004- February 2006	October 2005 - May 2007
May 2008 - January 2010	September 2007 - August 2009
May 2010 - January 2012	September 2009 - October 2011

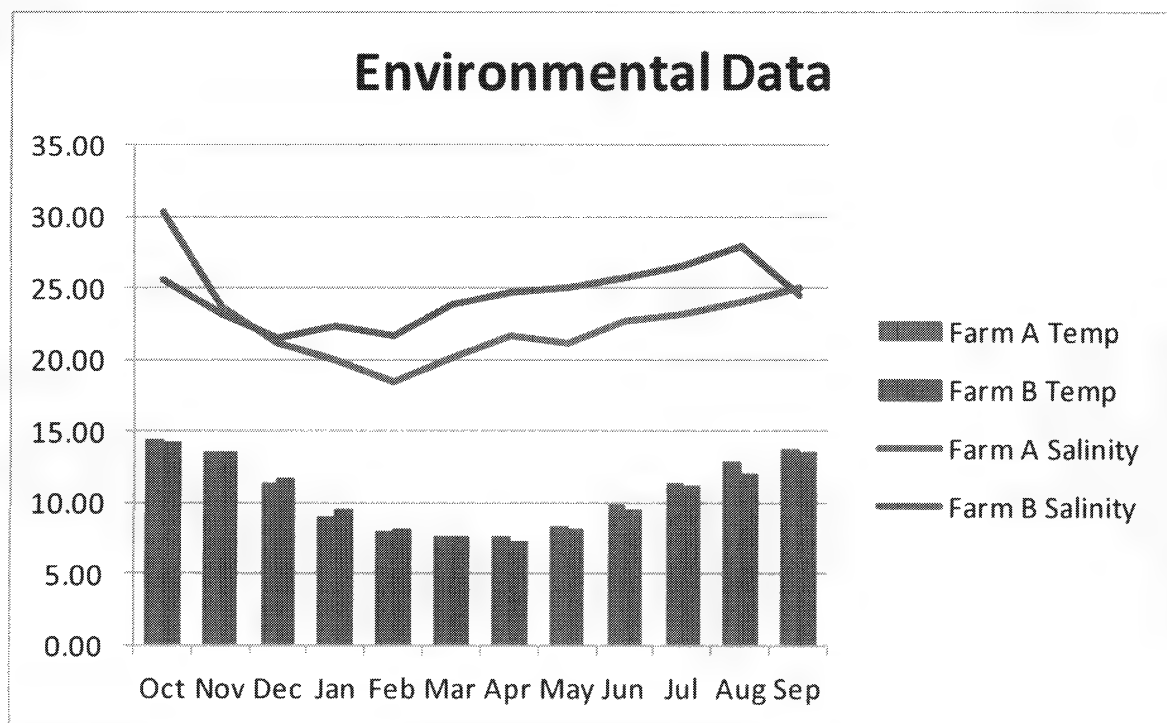
**Pages 63 to / à 66
are withheld pursuant to sections
sont retenues en vertu des articles**

20(1)(b), 20(1)(c)

**of the Access to Information Act
de la Loi sur l'accès à l'information**

Pen #2 January 2011 6	Pen #4 November 2010 2	Pen #6 November 2010 2	Pen #8 January 2011 6
Pen #1 October 2010 1	Pen #3 January 2011 6	Pen #5 December 2010 4	Pen #7 December 2010 4

Supplemental Figure 2. The farm cage system at Farm A. Pens 1 and 2 were closest to land. The dates and large numerals list the month, year, and order when IJAS was first observed in the pens.



Supplemental Figure 3. Mean water Temperature and Salinity for Farm A and B (May 2010 - Sept 2011) at 6 m.

**Pages 69 to / à 71
are withheld pursuant to sections
sont retenues en vertu des articles**

20(1)(b), 20(1)(c)

**of the Access to Information Act
de la Loi sur l'accès à l'information**

Histopathology and genomic characterization of idiopathic
jaundice and anemia syndrome in cultured Chinook salmon
(*Oncorhynchus tshawytscha*)

Kristina M. Miller^{*1}, Karia H. Kaukinen¹, Shaorong Li¹, Angela Schulze¹, Barbara Cannon²,
Tim Rundle², Gary D. Marty³, Sonja M. Saksida⁴

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Fisheries and Oceans Canada
Pacific Biological Station
3190 Hammond Bay Rd
Nanaimo, BC V9T 6N7
250-756-7155
Kristi.miller@dfo-mpo.gc.ca

²Creative Salmon Company Ltd.
PO Box 265
Tofino, British Columbia

³Animal Health Centre,
Ministry of Agriculture,
Abbotsford, BC, Canada

⁴British Columbia Centre for Aquatic Health Sciences,
Campbell River, BC, Canada V9W 5B1

*corresponding author

Keywords: jaundice syndrome, IJAS, anemia, salmon, aquaculture, piscine orthoreovirus,
microarray, gene expression profiling, anti-viral

Comment [D1]: to revise
with current address

**Pages 73 to / à 130
are withheld pursuant to sections
sont retenues en vertu des articles**

20(1)(b), 20(1)(c)

**of the Access to Information Act
de la Loi sur l'accès à l'information**

Miller-Saunders, Kristi

From: Miller-Saunders, Kristi
Sent: November-08-17 9:19 AM
To: Taylor, Nathan
Cc: Thomson, Andrew
Subject: FW: review of manuscript

FYI...Manuscript was sent back to industry September 29, 2017.

I need this resolved.

Kristi

From: [REDACTED] Creative Salmon [REDACTED]
Sent: November-08-17 8:11 AM
To: Miller-Saunders, Kristi; Taylor, Nathan; Marty, Gary D AGRI:EX; [REDACTED]
Cc: [REDACTED] - Creative Salmon
Subject: RE: review of manuscript

Hi Dr. Miller-Saunders,

I can assure you that there is no intent at delay now (nor was there when we were working on this last time).

Multiple calls to discuss a 3 year old manuscript is not to be unexpected.

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I can't speak to Gary's or [REDACTED] views on PRV or HSMI.

[REDACTED]

The manuscript has sat for 3 years, and was shelved by you, and I really appreciate you dusting it off and working on it again. I truly understand the frustration of the constant back and forth on this, then and now, and truthfully would like nothing better then to have this finished, but the reason for the back and forth last time hasn't disappeared because you resurrected the manuscript. There is still some fundamental disagreement on the discussion between co-authors. This has been further compounded by the use of the data from this manuscript and your discussion, in the 2017 paper. (without any of the co-authors knowledge or permission).

Creative Salmon is really in the middle of this, and reliant on scientists and vets for interpretation, and I'm really not sure what we do if the main co-authors disagree. (ie we are not some type of tie breaker) This has never happened to us before in the 25+ years of research we have participated in.

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s.19(1)

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Open to suggestions on a path forward.

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Sent: Tuesday, November 07, 2017 7:32 PM
To: [REDACTED] Creative Salmon; Taylor, Nathan
Cc: [REDACTED] - Creative Salmon
Subject: RE: review of manuscript

[REDACTED]
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I am really not sure what should take multiple calls when the only substantive changes to the manuscript were the inclusion of recent publications that added context to our findings. We spent almost 3 years going through this study previously. [REDACTED]

[REDACTED] I recognize that perhaps HSMI and jaundice are not causing such financial hardship to the industry that you deem it important enough to fully resolve, but our research beyond this study is suggestive of a consistent role of PRV in the development of both of these diseases. I have not overly played this role in the manuscript, although I do present briefly the recent studies linking PRV to jaundice in Pacific salmon in Norway, Chile, and Japan.

[REDACTED]
I too have a very busy schedule and will be away much of December, and I have every intent to get this paper submitted before I go away.

Kristi

From: [REDACTED] Creative Salmon [REDACTED]
Sent: November 6, 2017 7:46 AM

s.19(1)
s.21(1)(b)

To: Miller-Saunders, Kristi; Taylor, Nathan

Cc: [REDACTED] - Creative Salmon

Subject: RE: review of manuscript

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Best Regards,

[REDACTED]

[REDACTED]

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From: Miller-Saunders, Kristi [<mailto:Kristi.Saunders@dfo-mpo.gc.ca>]

Sent: Monday, October 30, 2017 2:29 PM

To: [REDACTED] Creative Salmon; Taylor, Nathan

Cc: [REDACTED] - Creative Salmon

Subject: FW: review of manuscript

I accidentally did not press reply all.

Kristi

From: Miller-Saunders, Kristi

Sent: October-30-17 2:29 PM

To: [REDACTED] - Creative Salmon'

Subject: RE: review of manuscript

Thank you for getting back to me [REDACTED]. At this point, I would not expect extensive edits to the intro, methods, or results, as we have hashed these out extensively in the past and nothing substantive has changed, and I have incorporated almost all of the suggestions from previous comments. In answer to your question, yes, we re-analysed all of your samples with our full agent panel, after the validation of the platform, and using the same methods we have applied on over 16,000 samples to date.

I would appreciate your getting your comments back by next Wed.

s.19(1)

Thanks,

Kristi

From: [REDACTED] - Creative Salmon [REDACTED]
Sent: October-30-17 2:14 PM
To: Miller-Saunders, Kristi; [REDACTED] - Creative Salmon
Cc: Taylor, Nathan
Subject: review of manuscript

Hi Dr. Miller,

We just wanted to touch base to let you know that we have been working on our review of the jaundice study manuscript and had hoped to get you comments/edits by the end of this month but unfortunately we will need a few additional days. We have had a couple of calls already and have another scheduled for Friday morning to review and discuss our edits and can hopefully get you the reviewed draft early next week.

We do have a question, were the samples from the study re-analyzed with your system since once it had been validated?

Regards,

[REDACTED]
[REDACTED]
Creative Salmon Co. Ltd.

T [REDACTED]
F 250-725-2885

C [REDACTED]
creativesalmon.com



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s.19(1)

Miller-Saunders, Kristi

From: Taylor, Nathan
Sent: November-08-17 8:14 AM
To: Miller-Saunders, Kristi
Subject: FW: review of manuscript

Is a phone call to sort this out possible? I worry about the conflict escalating by email and I have the sense that you managed to smooth things over [REDACTED] on the last go around.

From: [REDACTED] - Creative Salmon [REDACTED]
Sent: Wednesday, November 08, 2017 8:11 AM
To: Miller-Saunders, Kristi; Taylor, Nathan; Marty, Gary D AGRI:EX; [REDACTED]
Cc: [REDACTED] - Creative Salmon
Subject: RE: review of manuscript

Hi Dr. Miller-Saunders,

I can assure you that there is no intent at delay now (nor was there when we were working on this last time).

Multiple calls to discuss a 3 year old manuscript is not to be unexpected.

The degree of financial hardship for the industry or lack there of is not a factor in any of this. I might remind you that Creative Salmon initiated the request for the study in the first place to try to understand why we were seeing a small amount of jaundiced fish.

I can't speak to Gary's or [REDACTED]'s views on PRV or HSMI.

[REDACTED]

The manuscript has sat for 3 years, and was shelved by you, and I really appreciate you dusting it off and working on it again. I truly understand the frustration of the constant back and forth on this, then and now, and truthfully would like nothing better then to have this finished, but the reason for the back and forth last time hasn't disappeared because you resurrected the manuscript. There is still some fundamental disagreement on the discussion between co-authors. This has been further compounded by the use of the data from this manuscript and your discussion, in the 2017 paper. (without any of the co-authors knowledge or permission).

Creative Salmon is really in the middle of this, and reliant on scientists and vets for interpretation, and I'm really not sure what we do if the main co-authors disagree. (ie we are not some type of tie breaker) This has never happened to us before in the 25+ years of research we have participated in.

I really think we need some 3rd party scientific mediation (does this exist?) that can bring everyone together, and / or have the two interpretations represented in the manuscript.

I will discuss with the other co-authors about getting you the review we've done to date to continue this moving forward, but I really think its going to bring further frustration, and there is not agreement on publishing the manuscript until we can somehow resolve the difference in opinions.

s.19(1)

Open to suggestions on a path forward.

Thanks,

[REDACTED]
[REDACTED]
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From: Miller-Saunders, Kristi [mailto:Kristi.Saunders@dfo-mpo.gc.ca]
Sent: Tuesday, November 07, 2017 7:32 PM
To: [REDACTED] Creative Salmon; Taylor, Nathan
Cc: [REDACTED] - Creative Salmon
Subject: RE: review of manuscript

[REDACTED]
This does not work for me and is appearing to be very similar to past patterns of delay. I have heard nothing from either Gary or [REDACTED] so I am not clear on their intent.

I am really not sure what should take multiple calls when the only substantive changes to the manuscript were the inclusion of recent publications that added context to our findings. We spent almost 3 years going through this study previously.

[REDACTED] I recognize that perhaps HSMI and jaundice are not causing such financial hardship to the industry that you deem it important enough to fully resolve, but our research beyond this study is suggestive of a consistent role of PRV in the development of both of these diseases. I have not overly played this role in the manuscript, although I do present briefly the recent studies linking PRV to jaundice in Pacific salmon in Norway, Chile, and Japan.

[REDACTED]
I too have a very busy schedule and will be away much of December, and I have every intent to get this paper submitted before I go away.

Kristi

From: [REDACTED] - Creative Salmon [REDACTED]
Sent: November 6, 2017 7:46 AM
To: Miller-Saunders, Kristi; Taylor, Nathan
Cc: [REDACTED] - Creative Salmon
Subject: RE: review of manuscript

s.19(1)

s.21(1)(b)

Hi Dr. Miller-Saunders,

I'm sorry, we unfortunately will not have the review of the manuscript completed by this week.



As mentioned, it's a very busy time for everyone. Our next call to discuss this will be in the week of Nov 20th, and hope to get back to you shortly after that.

Best Regards,





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creativesalmon.com

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From: Miller-Saunders, Kristi [<mailto:Kristi.Saunders@dfo-mpo.gc.ca>]
Sent: Monday, October 30, 2017 2:29 PM
To:  Creative Salmon; Taylor, Nathan
Cc:  - Creative Salmon
Subject: FW: review of manuscript

I accidentally did not press reply all.
Kristi

From: Miller-Saunders, Kristi
Sent: October-30-17 2:29 PM
To:  - Creative Salmon
Subject: RE: review of manuscript

Thank you for getting back to me  At this point, I would not expect extensive edits to the intro, methods, or results, as we have hashed these out extensively in the past and nothing substantive has changed, and I have incorporated almost all of the suggestions from previous comments. In answer to your question, yes, we re-analysed all of your samples with our full agent panel, after the validation of the platform, and using the same methods we have applied on over 16,000 samples to date.

I would appreciate your getting your comments back by next Wed.

Thanks,

Kristi

From: [REDACTED] - Creative Salmon [REDACTED]
Sent: October-30-17 2:14 PM
To: Miller-Saunders, Kristi; [REDACTED] - Creative Salmon
Cc: Taylor, Nathan
Subject: review of manuscript

Hi Dr. Miller,

We just wanted to touch base to let you know that we have been working on our review of the jaundice study manuscript and had hoped to get you comments/edits by the end of this month but unfortunately we will need a few additional days. We have had a couple of calls already and have another scheduled for Friday morning to review and discuss our edits and can hopefully get you the reviewed draft early next week.

We do have a question, were the samples from the study re-analyzed with your system since once it had been validated?

Regards,

[REDACTED]
Creative Salmon Co. Ltd.

T [REDACTED]
F 250-725 2885

C [REDACTED]
creativesalmon.com



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s.19(1)

Miller-Saunders, Kristi

From: Miller-Saunders, Kristi
Sent: November-11-17 10:42 AM
To: cory.jackson@dfo-mpo.gc.ca
Cc: Taylor, Nathan
Subject: Jaundice Manuscript
Attachments: Jaundice study Manuscript_Sept 2017 Revision_clean_V2.docx

Cory,

I believe I promised to forward you the jaundice paper that we discussed a week ago FYI. If you have any questions, please do not hesitate to contact me. We [REDACTED]

[REDACTED] are presently conducting analyses that localize PRV within the area of tissue damage in the liver and kidney tissue diagnostic of the disease. We are planning on writing up a short communication of these findings as a separate study within the next month or so, and I will share it at that time.

Have a good weekend,

Kristi

s.21(1)(b)

**Pages 140 to / à 198
are duplicates of
sont des duplicatas des
pages 72 to / à 130**

Miller-Saunders, Kristi

From: Miller-Saunders, Kristi
Sent: November-15-17 9:33 AM
To: Parsons, Jay
Cc: Taylor, Nathan
Subject: FYI
Attachments: Jaundice study Manuscript_Sept 2017 Revision_clean_V2.docx

Hello Jay,

I heard from Nathan that Creative Salmon contacted you about the revision of the Jaundice manuscript I sent back to them in September and that I intend to move forward to publication. I was not sure if they provided you a copy of the manuscript. [REDACTED]

[REDACTED], 6 years after our initial discovery of the association between PRV and jaundice, there are papers published in three other countries showing the same relationship, one of which is cause and effect (Coho in Japan). We observe this same relationship between jaundice and high loads of PRV [REDACTED]

[REDACTED] We have done deep sequencing on multiple fish with jaundice and showed that there are no other viruses associated with the disease. Importantly, we now have in situ hybridization showing the localization of PRV within the kidney and liver cells where the necrotic lesions develop. This is very compelling evidence of more than a bystander relationship between this virus and disease in Chinook salmon, and we intend to prepare and submit a paper on this in situ work (done with audit fish, [REDACTED]) very soon.

Taken together, there is simply too much of a weight of evidence linking this virus with this disease, or very similar looking diseases in other countries in other Pacific salmon species, to dismiss this association, [REDACTED]
[REDACTED]

I thought you should know.

Kristi Miller-Saunders, PhD

Head, Molecular Genetics
Pacific Biological Station
3190 Hammond Bay Rd
Nanaimo BC V9T 6N7
250-756-7155
Kristi.Saunders@dfo-mpo.gc.ca

s.21(1)(a)

s.21(1)(b)

Pages 200 to / à 258

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14(a), 21(1)(b), 21(1)(a)

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Miller-Saunders, Kristi

From: Miller-Saunders, Kristi
Sent: November-16-17 1:58 PM
To: Taylor, Nathan
Subject: FW: ACRDP FINAL report
Attachments: Report_Creative Salmon ACRDP _ June 10_2013_FINAL.docx

Here is a copy of the last report I tried to submit, after well over a year of haggling back and forth with various drafts and reanalysing the data multiple times to suite their concerns. In essence, they did not want the inclusion of the PRV data, as they did not consider it "relevant" to the study, [REDACTED]
[REDACTED]

Kristi

From: Miller-Saunders, Kristi
Sent: June-13-13 12:10 PM
To: [REDACTED]
Cc: [REDACTED]; Kaukinen, Karia; Saunders, Mark; Parsons, Jay
Subject: ACRDP FINAL report

Dear [REDACTED]

Enclosed is the FINAL revision of the report. I will do no further revisions at this point, and I believe that I have more than dealt with all of the concerns noted by [REDACTED] Gary, you [REDACTED] over the past 1+ years.

The following is a synopsis of what has changed:

I have removed the data and information pertaining to wild salmon in this report as it was not part of this study, and has not been validated via a full genome sequence from wild fish. Moreover, I was recently made aware that this report, or this section of the report, was being circulated by someone involved in this project to other individuals within Industry without DFO permission or my knowledge. As this is IP that belongs to the crown and not even to this project, [REDACTED]
[REDACTED]

We have re-run the analysis [REDACTED]—removing all non-Jaundice "sick" fish (anemia and/or BKD positive) from the jaundice syndrome analysis for both liver and kidney, as well as removing all non-anemia "sick" fish (BKD positive; there were no jaundice only) and fish not scored for anemia from the anemia analysis. We obtained a significant gene list from all four analyses (two tissues, two analyses). We took three approaches to assess whether the signatures from anemia and jaundice alone were correlated: 1) we ran a bootstrap re-sampling correlation analysis on the respective gene lists, and obtained a correlation of >99.9% (i.e. less than 0.1% chance that the gene loadings in these analyses would be due to chance). 2) We assessed the degree of overlap in the top 100, 500 and (for kidney) 1000 genes for each of liver and kidney. For liver, taking the top 100 significant genes for Anemia (only 523 genes were significant for anemia and 1736 for Jaundice), 96% were also significant for Jaundice, top 500 yielded 86% overlap with Jaundice significant genes. For kidney, top 100 Anemia genes yielded 92% overlap with Jaundice, top 500 was 74%, and top 1000 was 65% (there were 1997 significant genes for Anemia and 2394 for Jaundice), 3) we ran a hierarchical cluster analysis putting all samples not used in the statistical analysis back in, and determined if they clustered similarly when clustering was based on the significant genes in each analysis. We also re-ran the Jaundice/anemia combined analysis—removing the BDK positive fish. We made a new table that shows

these results (number of genes significant in each analysis and classification based on hierarchical clustering.

As we discussed in the report previously, there are a few "outlier" fish that come out of this analysis—i.e. fish that cluster more intermediately (most notable in Jaundice/anemia combined analysis "a" cluster (1006, 1001, 1004, 1012, 1013), and generally do not cluster the same in all analyses (1006, 1001, 1004). You will note that two BKD positive fish clustered more often than not in "A" while two clustered consistently in "B".

I have added this new analysis in, as well as dealing with most of your additional comments.

I will be moving forward with the preparation of a peer reviewed manuscript based on this study, which is the "output" that was originally anticipated.

Kristi Miller

Head, Molecular Genetics Section

Pacific Biological Station

Nanaimo, BC

phone (250) 756-7155

fax (250) 756-7053

Please Note new email address effective Jan 2008:

Kristi.Miller@dfo-mpo.gc.ca

s.21(1)(b)

ACRDP Final Project Report

PART I

1. Project #:

2. Project Title:

Genomic characterization of jaundice-associated mortality events in cultured Chinook salmon

3. Project Duration:

1 April, 2011 – 31 March, 2012

4. Project Leader, contact information:

Project Manager

Karia Kaukinen, MSc
Molecular Genetics,
Fisheries and Oceans Canada
Pacific Biological Station
3190 Hammond Bay Rd
Nanaimo, BC V9T 6N7
250 759-8358
karia.kaukinen@dfo-mpo.gc.ca

Project Leader

Dr. Kristi Miller
Molecular Genetics,
Fisheries and Oceans Canada
Pacific Biological Station
3190 Hammond Bay Rd
Nanaimo, BC V9T 6N7
250-756-7155
Kristi.miller@dfo-mpo.gc.ca

5. Industry partner(s):



Creative Salmon Company Ltd.
PO Box 265
Tofino, British Columbia
250-725-2884



s.19(1)

6. Expenditures and variance from budget:

	Contribution	Initial budget	Actual expenditure	Difference
Industry \$	6,000	6,000	6,000	0
Industry (in kind)	16,200	16,200	16,200	0
ACRDP (\$)	72,758	72,758	72,758	0
Other DFO (\$ and in kind)	4,000	4,000	4,000	0
Partners (\$ and in-kind)	1,750	1,750	1,750	0

7. Expertise developed during the project (e.g., within DFO, industry, graduate students etc.):

8. General Comments:

s.20(1)(b)

s.20(1)(c)

Page 265

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20(1)(b), 20(1)(c)

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PART II

9. Project rationale (e.g., background information, why solving the problem was of interest to industry, project hypothesis and goals):

A Creative salmon farm-site on the west coast (farm A, Fig 1) has experienced consistent low level mortality with a unique clinical presentation of mild to severe yellow discolouration of the skin (jaundice) and pale gills. The cause has not been identified using standard diagnostic methods, but is hypothesized to be of either viral or environmental toxin origin. The project used a functional genomics approach to elucidate the genes differentially expressed in association with jaundice syndrome. The goal was to increase our understanding of the syndrome. The project also aimed to conduct a thorough epidemiological study to better understand why some farms are more affected and to determine the overall level of mortality attributable to the condition. The ultimate goal was to move closer towards identifying the cause of jaundice that will enable the farms to track, predict, and/or mitigate this syndrome.

10. Short summary of project methods (e.g., experimental and analytical procedures followed, deviations from the originally proposed methods):

Collections were made from two farm sites located on the west coast of Vancouver Island, A and B, with farm A showing the highest incidence of mortality associated with the jaundice syndrome (see epidemiology) (Fig 1). Moribund or recently dead fish on farm A were collected by divers, and "healthy" swimming reference fish were collected from net pens using hook and line or during harvest in Farm B. From all fish, RNA was extracted from tissue samples of liver, kidney, heart, spleen and gill. The functional genomics study employed a 44K gene oligonucleotide salmonid microarray to identify genes correlated with the jaundice syndrome. Histopathology was done on 15 healthy and 13 freshly dead (less than 12 hours)/sick fish; incorrect preservation of samples collected on April 27, 2011 (6 healthy and 2 sick fish) precluded their analysis by histopathology. RNA was extracted from tissue samples of liver, kidney, heart, spleen and gill. The functional genomics study employed a 44K probe oligonucleotide salmonid microarray to identify genes correlated with the jaundice syndrome.

Thirty-five liver and thirty-six kidney samples were run on the arrays against a reference control containing RNA from all experimental samples and both tissues. The reference control is required to normalize variance in concentration of probes on the array, as well as array to array variability and is thus not meant to represent an experimental sample (i.e. this is different from the "reference" fish that do not show signs of jaundice which were also run individually on arrays and

contrasted with sick fish). After normalization, arrays were analysed statistically using T-tests to identify genes associated with jaundice syndrome, histological lesions associated with the jaundice syndrome, and with high loads of piscine reovirus (see below), and principal components analysis (PCA) was conducted to identify the major physiological trajectories of the data. Functional analyses were performed using Pathway Studio version 9.0.

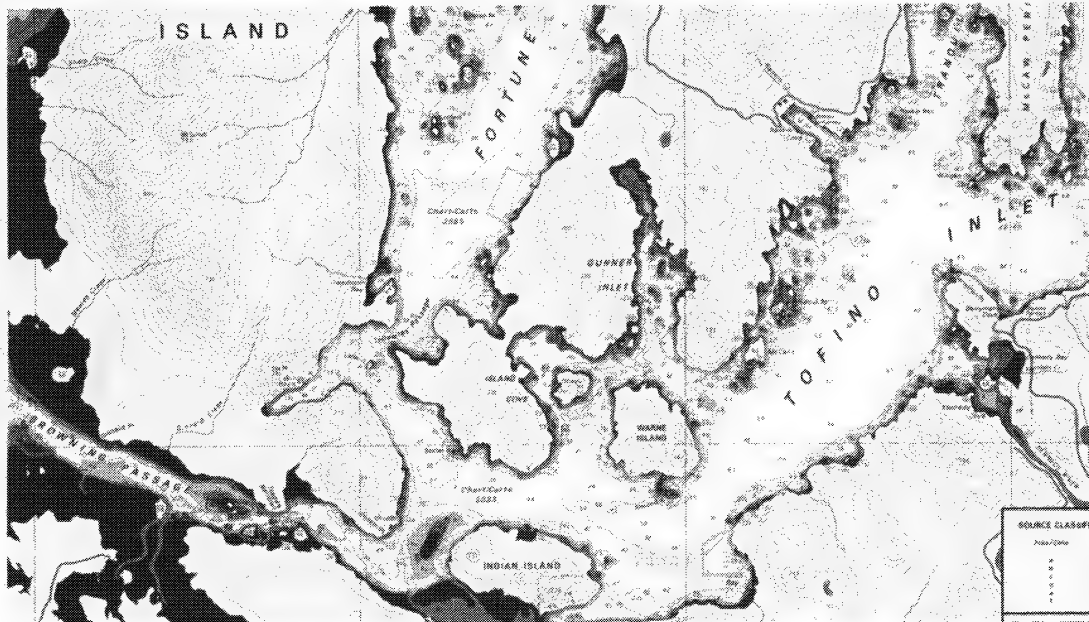


Figure 1. Location of Creative Salmon farm sites.

Quantitative RT-PCR was performed on a subset of host genes in gill tissue aimed at elucidating potential environmental effects (most notably salinity) on gene expression associated with jaundice. Gill tissue was not run on the arrays.

The only deviation from the original plan was the addition of a Fluidigm BioMark scan of infectious agents in liver tissue using published RT-PCR TaqMan assays for 13 infectious agents identified in association with mortality events in salmon and 1 newly identified microbe for which the association with disease is unknown. Correlation analyses were performed with each microbe surveyed to determine if any were associated with the jaundice syndrome. Piscine reovirus (PRV) is the only tested infectious agent that was correlated with the jaundice syndrome. Therefore, additional study was done to validate the PRV results. The other infectious agents were not considered further for this study. Additional study included ABI 7900 RT-PCR validation of PRV in liver, kidney, gill, spleen and heart tissues. Microscopic lesions that occurred with PRV CT's < 26 (indicating higher viral loads) were also identified.

11. Key results (include graphs, data tables, photos, etc. where applicable):

A. Detailed deliverables of project

Page 268

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20(1)(b), 20(1)(c), 19(1)

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20(1)(b), 20(1)(c)

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VI. Osmoregulatory assessment of gill tissue

VII. References

- Chaurushiya, M. S., & Weitzman, M. D. (2009). Viral manipulation of DNA repair and cell cycle checkpoints. *DNA repair*, 8(9), 1166-1176.
- Finstad, OW, Falk K, Lovoll M, Evensen, O, Rimstad, R. 2012. Immunohistochemical detection of piscine reovirus (PRV) in hearts of Atlantic salmon coincides with the course of heart and skeletal muscle inflammation (HSMI). *Veterinary Research*. 43: 27.
- Forrest JC, Dermody TS. 2003. Reovirus Receptors and Pathogenesis. *Journal of Virology* 77:9109-9115.
- Haller BL, Barkon ML, Vogler GP, Virgin HW 4th. 1995. Genetic mapping of reovirus virulence and organ tropism in severe combined immunodeficient mice: organ-specific virulence genes. *Journal of Virology* 69: 357-364.
- Garseth AH, Fritsvold, C, Opheim M, Skjerve E, Biering E. 2012. Piscine reovirus (PRV) in wild Atlantic salmon, *Salmo salar* L., and sea-trout, *Salmo trutta* L., in Norway. *Journal of fish Diseases* 36: 483–493. DOI: 10.1111/j.1365-2761.2012.01450
- Kloetzel. PM. 2001. Antigen processing by the proteasome. *Nature Reviews in Molecular Cell Biology* 2: 179-188.
- Kongtorp RT, Taksdal T, Lyngøy A. 2004. Pathology of heart and skeletal muscle inflammation (HSMI) in farmed Atlantic salmon *Salmo salar*. *Diseases of Aquatic Organisms* 59:217-224.
- Kongtorp RT, Halse M, Taksdal T, Falk K. 2006. Longitudinal study of a natural outbreak of heart and skeletal muscle inflammation in Atlantic salmon, *Salmo salar* L. *Journal of Fish Diseases* 29: 233-244.
- Levy GA, Mingfeng L, Ding J, Yuwaraj S, Leibowitz J, Marsden PA, NingQ, Kovalinka A, Phillips MJ. 2000. Molecular and functional analysis of human prothrombinase gene (HFGL2) and its role in viral hepatitis. *American Journal of Pathology*. 156(4): 1217-1225.

- Løvoll M, Alarcón M, Jensen BB, Taksdal T, Kristoffersen AB, Tengs, T. 2012. Quantification of piscine reovirus (PRV) at different stages of Atlantic salmon *Salmo salar* production. *Diseases of Aquatic Organisms* 99: 7-12.
- Mikalsen AB, Haugland O, Rode M, Solbakk IT, Evensen O. 2012. Atlantic Salmon Reovirus infection causes a CD8 T cell myocarditis in Atlantic Salmon (*Salmo salar* L.). *PLoS ONE* 7(6): e37269. doi:10.1371/journal.pone.0037269
- Mbisa JL. 2002. Investigation of the virus-host cell interactions involved in reovirus inclusion formation. PhD Dissertation, University of Ottawa (<https://www.ruor.uottawa.ca/fr/handle/10393/6267>)
- Palacios G, Lovoll M, Tengs T, et al. 2010. Heart and skeletal muscle inflammation of farmed salmon is associated with Infection with a novel reovirus. *PLOS One* 5(7): e11487.
- Sharma JM, Karaca, K and Pertile. 1994. Virus-induced immunosuppression in chickens. *Poultry Science* , 73: 1082–1086.
- Sherry B, Bloom MA. 1994. Multiple viral core proteins are determinants of reovirus-induced acute myocarditis. *Journal of Virology* 68: 8461-8465.
- Wiik-Nielsen CR, Løvoll M, Sandlund N, et al. 2012. First detection of piscine reovirus (PRV) in marine fish species. *Diseases of Aquatic Organisms*. 97:255-258.

VIII. Recommendations to industry on next steps

- Laboratory challenge study will cell free size-filtered lysates to establish whether the piscine reovirus can cause signs of jaundice in BC Chinook salmon.
- Include other diagnostic testing such as hematocrit, blood assessment to better understand the cause of the anemia associated with the syndrome
- Better define risk factors contributing to this syndrome

12. Resulting key improvements to sustainable aquaculture and scientific advancements:

- Assessment of a potentially powerful novel diagnostic tool - genomic characterization as a diagnostic tool for fish health
- Illustrating a multidisciplinary approach (genomics, standard veterinary diagnostic techniques, histopathology, epidemiology) in attempt to solve fish health issues

13. Suggested next steps, future research/development/innovation needs:

- Conduct laboratory studies to assess the role of PRV load and the potential to elicit jaundice presentation or disease.

- If PRV is shown in follow-up studies to be causative of the Jaundice syndrome,
 - Routine monitoring of PRV and biomarkers for disease could enable more precise tracking of the virus and disease progression.
 - Biomarkers alone could be useful if PRV is not causative.
- Whole genome sequencing of nucleic acids (DNA and RNA) of affected fish to gain the full sequence of PRV in BC
- Phylogenetic analysis of the full sequence of the piscine reovirus here in BC to determine its relationship with European strains.

14. Copies of publications, reports or articles produced in reference to the project:
N/A

15. Identify any invention or innovation that may have resulted from this Project, including any new process or technique.

- High throughput microbe screening on the Fluidigm BioMark system was developed and applied during the course of this study, although it was not principally motivated or financed by this study.

PART III

Declaration:

I _____ have completed the report and declare that to the best of my knowledge the report is accurate.

Signature

Date

Approved by:

DFO Project Authority

Date

Industry Project Authority

Date

Miller-Saunders, Kristi

From: Taylor, Nathan
Sent: November-16-17 10:10 AM
To: Miller-Saunders, Kristi
Subject: unapproved ACRDP report

Hi Kristi,

Do you have a copy of the draft Creative Salmon report that collaborators would not sign off on?

N.

Nathan G. Taylor, Ph.D.
Division Manager | Directeur de secteur
Aquatic Diagnostics Genomics and Technology Division | Division des diagnostics, la genomique, de la technologie
aquatique
Fisheries and Oceans Canada | Peches et Oceans Canada
Pacific Biological Station | Station biologique du Pacifique
250-756-7395

Dickie, Catherine

From: Moore, Wayne
Sent: November 16, 2017 10:21 AM
To: Taylor, Nathan; Lowe, Carmel
Subject: Re: URGENT

I sent to Carmel all we could find. My understanding is that prior to 2013 the agmts were held in the region and Brenda might be your best contact.

Sent from my BlackBerry 10 smartphone on the Rogers network.

From: Taylor, Nathan
Sent: Thursday, November 16, 2017 1:18 PM
To: Moore, Wayne; Lowe, Carmel
Subject: RE: URGENT

Hey Wayne – did you have any luck finding the Collaborative Agreement for the project in the system? I've been looking on my end as well with no luck.

N.

From: Moore, Wayne
Sent: Wednesday, October 25, 2017 5:03 PM
To: Lowe, Carmel
Cc: Taylor, Nathan
Subject: RE: URGENT

This is the project I think...trying to find an e-copy of agreement in system.

Photo: Mike Foreman (DFO)

Genomic characterization of jaundice-associated mortality events in cultured Chinook Salmon

This project was undertaken to determine whether a jaundice syndrome associated with low-level mortality in Chinook Salmon farmed in Tofino Inlet was more likely caused by a viral infection or an environmental toxin. Our project combined genomics, histopathology, epidemiology, and standard veterinary diagnostic techniques to determine which of these etiologies was more likely involved. Prevalence of jaundice syndrome was consistently greater at farm A than B over multiple years. The most significant lesions included tissue necrosis and fibrin deposition, primarily in kidney and liver. Genomic signatures comprised of thousands of differentially regulated genes occurred in both kidney and liver, with strong effects on immune response, proteolysis, metabolism, and cell cycle. The types of immune processes elicited were highly consistent with a viral etiology (response to virus, response to exogenous dsRNA, Stat signaling, type-I interferon response, viral replication); conversely, there was no signal that could be construed as toxicant-response. Based on a PCR survey of infectious agents, fish with jaundice syndrome commonly had greater loads of piscine reovirus than did healthy fish. This virus is purported to cause heart and skeletal muscle inflammation (HSMI) in Atlantic Salmon in Europe, but the lesions associated with HSMI are very different from lesions in Chinook Salmon with jaundice syndrome. Tissue tropism is not uncommon with reovirus infections, so it is possible that this virus could affect different tissues in different species. As a whole, this research

supports a viral etiology, however, more research will be required to determine if the piscine reovirus is causative of, associated with, or merely a bystander to the jaundice syndrome.

apr. 2011 – apr. 2012

Funded by: DFO – Aquaculture Collaborative Research and Development Program (ACRDP) **co-funded by:** Creative Salmon

project lead: Kristi Miller (DFO)

Project team: Karia Kaukinen, Brad Davis (DFO); [REDACTED] (CAHS)

collaborators: Gary Marty (BC Ministry of Agriculture)

Contact: Kristi.Miller@dfo-mpo.gc.ca

From: Lowe, Carmel
Sent: October 25, 2017 7:24 PM
To: Moore, Wayne <Wayne.Moore@dfo-mpo.gc.ca>
Cc: Taylor, Nathan <Nathan.Taylor@dfo-mpo.gc.ca>
Subject: RE: URGENT

KMS

Carmel
Carmel Lowe, Ph.D.
Regional Director Science | Directrice régionale des sciences
Fisheries and Oceans Canada | Pêches et Océans Canada
Pacific Biological Station | Station biologique du Pacifique
3190 Hammond Bay Rd. Nanaimo, BC, Canada V9T 6N7
Carmel.Lowe@dfo-mpo.gc.ca
Telephone | Téléphone 250-756-7177
Facsimile | Télécopieur 250-729-8360
Government of Canada | Gouvernement du Canada

From: Moore, Wayne
Sent: Wednesday, October 25, 2017 4:23 PM
To: Lowe, Carmel <Carmel.Lowe@dfo-mpo.gc.ca>
Cc: Taylor, Nathan <Nathan.Taylor@dfo-mpo.gc.ca>
Subject: Re: URGENT

Will try to find. it has been a few years. Who is PI?

Sent from my BlackBerry 10 smartphone on the Rogers network.

From: Lowe, Carmel
Sent: Wednesday, October 25, 2017 7:20 PM
To: Moore, Wayne
Cc: Taylor, Nathan
Subject: URGENT

Wayne,
Can you send Nathan and I a copy of the ACRDP proposal that relates to the hot issue of the day? Neither Nathan nor I have a copy of it and the PI is on the C3 boat....

s.19(1)

Carmel

Carmel Lowe, Ph.D.

Regional Director Science | Directrice régionale des sciences

Fisheries and Oceans Canada | Pêches et Océans Canada

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Telephone | Téléphone 250-756-7177

Facsimile | Télécopieur 250-729-8360

Government of Canada | Gouvernement du Canada

McLeod, Patricia

From: Miller-Saunders, Kristi
Sent: November 16, 2017 2:01 PM
To: Taylor, Nathan
Subject: FW: Creative salmon report

Response from Jay back in 2013

From: Parsons, Jay
Sent: July-08-13 6:45 AM
To: Miller-Saunders, Kristi; Saunders, Mark
Subject: RE: Creative salmon report

Kristi,

Thank you for following up on the report [REDACTED]. I am glad to hear we are making progress in getting this project finalised. If I recall correctly, last time we had a teleconference call to discuss this project, there was a request to do some additional lab work and some questions about the interpretations of the data. It looks like the requested lab work has been completed and I think it is only reasonable to allow [REDACTED] a final opportunity to review and comment on the report based on the additional work and any potential changes to the wording in the report that have been made. From an ACRDP perspective, it is important that the collaborators are willing to sign off on the final report. Furthermore, I fully support the idea that this needs to move to publication. Presumably some of the collaborators on this project might be co-authors on any publication(s) that you will be submitting. Hence, there will need to be a reconciliation and consensus on the wording and interpretation of the results for any manuscript prepared for submission. So my advice is that time spent working through any particular issues on the report now will only help facilitate the final publication of this research.

I will follow-up [REDACTED] and request a timeline on when he will provide comments and ask if a follow-up teleconference call needs to be organised.

Mark are you in support of this approach?

Thanks, Jay

Jay Parsons, PhD
Director | Directeur
Aquaculture Science Branch | Direction des sciences de l'aquaculture
Fisheries and Oceans Canada | Pêches et Océans Canada
200 Kent Street, Stn 12E239 Ottawa, ON Canada K1A 0E6
tel. | tél. 613-990-0278 fax. | téléc. 613-990-0313
email | courriel Jay.Parsons@dfo-mpo.gc.ca

From: Miller-Saunders, Kristi
Sent: July-04-13 3:58 PM
To: Saunders, Mark; Parsons, Jay
Subject: Creative salmon report

s.19(1)

I sent this report back to Creative salmon in the middle of June and I cc'd both of you at that time. As I had not heard anything back, I called [REDACTED] who said that they were going to come back with comments and revisions again, but that [REDACTED] was handling this. In my email, I made it clear that we were done with revisions. [REDACTED]
[REDACTED] This work needs to move to publication, [REDACTED]

Thanks,

Kristi Miller

Head, Molecular Genetics Section

Pacific Biological Station

Nanaimo, BC

phone (250) 756-7155

fax (250) 756-7053

Please Note new email address effective Jan 2008:

Kristi.Miller@dfo-mpo.gc.ca

s.19(1)

s.21(1)(a)

s.21(1)(b)

Parsons, Jay

From: [REDACTED] - Creative Salmon <[REDACTED]>
Sent: Friday, November 17, 2017 11:30 AM
To: Parsons, Jay; [REDACTED] - Creative Salmon
Subject: RE: call to discuss ACRDP manuscript
Attachments: RE: call to discuss ACRDP manuscript; RE: call to discuss ACRDP manuscript

Hi Jay,
Yes definitely, a good idea to include Nathan as well. He has already accepted the meeting invitation.
Talk next week,
[REDACTED]

From: Parsons, Jay [<mailto:Jay.Parsons@dfo-mpo.gc.ca>]
Sent: Friday, November 17, 2017 5:48 AM
To: [REDACTED] - Creative Salmon; [REDACTED] - Creative Salmon
Subject: RE: call to discuss ACRDP manuscript

[REDACTED] Is it ok if we include Nathan Taylor in the discussion as well, as he is the direct manager of KMS. Thanks, Jay

-----Original Appointment-----

From: [REDACTED] - Creative Salmon <[REDACTED]>
Sent: Monday, November 06, 2017 1:11 PM
To: [REDACTED] - Creative Salmon; Parsons, Jay; [REDACTED] Marty, Gary D AGRI:EX
(Gary.Marty@gov.bc.ca); [REDACTED] - Creative Salmon
Subject: call to discuss ACRDP manuscript
When: Tuesday, November 21, 2017 9:00 AM-9:30 AM (UTC-08:00) Pacific Time (US & Canada).
Where: conference call

Please call: [REDACTED]
Participant Code: [REDACTED]

s.16(2)(c)
s.19(1)

**Pages 303 to / à 1623
are withheld pursuant to section
sont retenues en vertu de l'article**

23

**of the Access to Information Act
de la Loi sur l'accès à l'information**

Miller-Saunders, Kristi

From: Miller-Saunders, Kristi
Sent: November-23-17 4:52 PM
To: Lowe, Carmel
Subject: BCSFA meeting information, As requested

BC Salmon Farmers Association Workshop Exploring PRV and HSMI in Europe and B.C.

On November 27-28th, 2017, the BC Salmon Farmers association, in collaboration with the BC Center for Aquatic Health Sciences, is hosting a workshop in Campbell River to explore the state of the science on PRV and the disease Heart and Skeletal Muscle Inflammation (HSMI). In addition to a strong representation of scientists from Fisheries and Oceans Canada, they have invited speakers from Norway (academics and industry scientists), the US Geological Service, University of BC, and the BC Center of Aquatic Health Services. The workshop will be moderated by George Iwama from Quest University and Gary Marty from the BC Ministry of Agriculture. Presentations will provide an overview of the virus and disease manifestation in Norway and the Atlantic and Pacific coasts of Canada in Atlantic and Pacific salmon. The Norwegian scientists will also touch on mitigation measures being put in place in Norway to tackle this PRV-related disease. Given there has been strong debate amongst researchers in BC over the risk that PRV poses to wild salmon, this meeting provides an important venue for the key researchers and industry to come together and forge a path forward to understand the knowledge gaps in our understanding of impacts and risks associated with PRV in BC salmon.

Kristi Miller-Saunders, PhD

Head, Molecular Genetics
Pacific Biological Station
3190 Hammond Bay Rd
Nanaimo BC V9T 6N7
250-756-7155
Kristi.Saunders@dfo-mpo.gc.ca

Gheorghe, Tricia

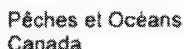
From: Gheorghe, Tricia
Sent: November-23-17 2:47 PM
To: Parsons, Jay
Subject: RE: acrdp proposal
Attachments: P-11-02-007 Proposal.pdf; P-11-02-007 Report Final.doc; P-11-02-007 CA Signed.pdf

Included the proposal, final report, and signed CA.

Cheers!

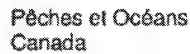
From: Parsons, Jay
Sent: November-23-17 2:31 PM
To: Gheorghe, Tricia
Subject: acrdp proposal

Tricia, could you please resend me the acrdp proposal from pacific region with creative salmon from a few years ago again. Thanks, Jay



→ #5
→ #8 IV

001626





Aquaculture Collaborative Research and Development Program (ACRDP)

PROPOSAL GUIDELINES

Please submit a proposal giving the following details:

1. Project title: **Genomic characterization of jaundice-associated mortality events in cultured Chinook salmon**

2. Name, address and position of project manager

Karia Kaukinen
Bi-02 in the Molecular Genetics Laboratory
Pacific Biological Station
3190 Hammond Bay Rd
Nanaimo, BC V9T 6N7
250-759-8358

3. Description of project work team and required qualifications for key positions (with names, addresses, titles, and CV's where available; maximum length 4 pages per team member)

Kristi Miller, PhD
Head, Molecular Genetics, PBS
Genomics lead, genomics data analysis and interpretation

Karia Kaukinen, MSc
BI-02 Molecular Genetics, PBS
Project manager, Genomics laboratory research, genomics data analysis

Center for Aquatic Animal Health Sciences
871A Island Highway, Campbell River BC V9W 5B1
Fish Health expertise, industry liaison, epidemiology expertise

- Creative Salmon
Tofino BC
Industry Partner

4. Project problem / rationale (maximum length ½ page)

Over the past seven years mortalities of Chinook salmon farmed in the Tofino inlet have been observed with unique clinical presentation. The salmon present with mild to severe yellow discolouration of the skin (jaundice). This is most evident on the abdomen and around the eyes. These fish also have very pale gills indicating anemia. Internal signs include pale livers and often the stomachs of the fish are empty indicating the fish have not eaten for a number of days

Canada



although the overall condition of the fish is good. Grossly the other organs appear unaffected. The clinical presentation is very different from Marine Anemia syndrome, another Chinook salmon disease, which typically presents with splenomegaly, renomegaly, and anemia (Kent and Poppe 1998).

Histological examination has found severe liver and kidney damage (hydropic degeneration). The proposed etiology includes a pathogen or exposure to a negative environmental influence (hereafter referred to as an undefined toxin). Repeated testing using traditional diagnostic tests have been unable to identify a pathogen. Tests including classical bacterial culture, viral cell culture, PCR, blood assessment and histopathology have yielded negative results for pathogens including *Renibacterium salmoninarum* (BKD), *Listinella sp* (vibriosis), VHSV, IHNV, ISAV, VEN, EIBS, *Loma salmonae*, and *Nucleospora salmonis* (marine anemia).

Little is known of the epidemiology of the condition. It affects fish that have been in sea water for greater than 6 months and therefore is not considered related to smolt quality. There appears to be a seasonal pattern to this condition with clinical signs and mortalities observed late fall/early winter (December) spiking in the winter and apparently resolving by early summer. This condition is most typically observed at the farm site operated by Creative Salmon that contains the greatest freshwater influence, which is one reason to suspect an environmental effect may be at play, although it is sometimes observed at relatively lower incidence levels at other farm sites. It has been seen in most of the generations stocked at the freshwater-influenced farm even though the company operates single year class sites with a fallow period before re-stocking. At the most affected farm most often one or two pens of fish are severely affected, however the condition may be seen in many of the pens. The mortalities levels in most heavily affected pens typically would be several folds higher than the other pens on the farm. For example in January 2011, the single affected pen (of an 8 pen site) disproportionately made up 35% of the mortalities grossly examined. Of the mortalities examined from this single pen over 77% of the fish examined exhibited jaundice. Total mortality attributed to this condition has not been fully assessed although at certain times of the year it can be as significant as other diseases.

Currently there are no tools available to manage the problem. A better understanding of the epidemiology and etiology would enable us to develop these tools.

5. Project objectives (maximum length ½ page)

Our main objective is to apply functional genomics technology to gain a better understanding of the factors that may underlie the poorly understood jaundice-related disease experienced by farmed Chinook salmon in Tofino. Of most import, Creative Salmon managers need to know whether this disease is more likely the result of an infectious agent or environmental conditions. If the genomic signature indicates that an infective agent is likely involved, they will pursue the identification of this agent through 454 sequencing of affected tissues in a follow up study. If the genomic signature is more likely associated with environmental conditions at this farm site, e.g. low salinity, toxicants, or other factors, follow-up studies could be performed to assess the most likely environmental mechanisms. In either case, knowledge of the mechanisms leading to this disease will potentially provide managers with tools to track, predict, and/or potentially mitigate the impact of this disease in future.



Our other objective is to improve our understanding of the epidemiology of the condition – why is the condition more prevalent at one farm as compared to the others in the same area, or in some pens and not others? This would include examining the mortality pattern, and determining overall mortality attributed the condition, and the environmental factors associated with it.

6. Description of work and experimental protocol (maximum length 2 pages)

Fish on Creative Salmon's farms are regularly screened for health, and the presence of jaundice is one of the metrics that is tracked bi-weekly in each netpen at each site. While mild jaundice can occur to some degree at all sites, jaundice-related mortality is predominant at the farm with the greatest freshwater influence. Despite extensive histological study, we still do not understand whether the jaundice may result from an infective agent or may be a manifestation of environmental conditions, possibly relating to low salinities, in the winter, or a combination of both. Hence, we need to design an experiment that considers both possibilities.

The molecular genetics laboratory has successfully used microarray approaches on wild fish to assess unknown factors associated with poor performance (e.g. Miller et al. 2010) and transcriptional responses to shifting environments (Miller et al. 2009; Evans et al. In Review). We have also conducted microarray studies of host response to disease (Miller et al. 2007; IHNV) and have conducted studies with Peter Ross at IOS on the influence of toxicant exposure on immune response to *Vibrio* (data still in preparation for publication). Moreover, we have been working closely with a bioinformatics group at UBC, lead by Dr. Paul Pavlidis, on the development of meta-analysis tools to identify correlated profiles among microarray experiments. Hence, we have the experience and expertise to undertake this exploratory study. We will use similar experimental designs and approaches as we have used in previous studies (e.g. Miller et al. 2009) whereby we apply balanced replication across each biological variable, or treatment, of interest. Here, treatments are not really treatments, as one would define in a controlled laboratory study, but rather biologically meaningful entities, like sample sites, disease state, and life-history stage.

Approach: If an infective agent is involved, it is important to determine whether it is present in smolts used to stock the farm sites, or whether it likely emanates from the marine environment. As such, our study will include smolts used to stock net pens in 2011 (Treatment 1; note that the sample size of smolts would only detect positives that affected 10% or more of fish, so it is not an exhaustive, definitive assessment of the role of freshwater). To control for the environment, we will contrast apparently healthy (no evidence of jaundice) fish a farm that is not substantively affected by jaundice (Treatment 2) with healthiest fish that can be obtained sampled from the affected freshwater-influenced farm (Treatment 3). To obtain healthy fish, we will chum fish from netpens that have been shown to have the lowest levels of jaundice and conduct histological analyses to ascertain their state of health. Fish that were collected in this manner but deemed to be positive for, but not dying of, jaundice at the time of collection will also be included in the analysis to control for the effects of morbidity (Treatment 4). Finally, moribund fish with clear evidence of jaundice will be included in the study (Treatment 5). Multiple tissues from all collected fish will be examined histologically.



Head and Posterior kidney, spleen, liver, heart, muscle, gill, and blood of 10-15 fish will be collected for each "treatment" category.

- I. Smolts
- II. Healthy fish from unaffected farm at mouth of the inlet
- III. Healthy fish from affected farm
- IV. Fish with histological signature of jaundice but not moribund at affected farm
- V. Moribund fish with histological signature of jaundice at affected farm

In anticipation of this study, some of the samples of moribund and jaundiced fish were collected during a mortality event at the end of February 2011. Additional samples of jaundiced but not moribund and healthy fish from both farm sites will be collected in early March, along with additional moribund and jaundiced fish, if still present. Smolts will be collected in April before they are put to sea.

The microarray study will be performed on cDNA from liver tissue, as liver is one of the most severely affected organs and is also the primary tissue for detoxification. We will keep the remaining tissues for potential future study. In a balanced experimental design, twelve biological replicates (individuals) will be included for each of the five treatments, with the total study comprising 60 arrays. The Salmonid Agilent 4x44K oligonucleotide arrays developed through the cGRASP program by Ben Koop's laboratory at University of Victoria will be used in the study, with approaches similar to those we have used in other studies (e.g. Miller et al 2009, 2011). A reference sample comprised of liver cDNA from all of the individuals used in the study (labeled with Alexa555) will be hybridized along with the experimental sample (labeled with Alexa647) on each array. After slide quality assessment and Lowess normalization, arrays will be statistically analysed using both supervised (multifactorial ANOVA with posthoc testing via Mann Whitney U t-test) and unsupervised (Principle Component Analysis) approaches to identify transcriptional differences among treatments and the main physiological trajectories in the data. Functional analysis of the biological processes over-represented among the differentially regulated genes will be determined using the programs DAVID (<http://niaid.abcc.ncifcrf.gov/>) and PathwayStudio (Ariadne Genomics). Further information on the functional role of the most significantly differentially regulated genes will be gleaned from the protein literature mining website iHop (<http://www.iHop-net.org/UniPub/iHOP/>).

Many salmon diseases have already been characterized by microarrays (e.g. Miller et al. 2007, Rise et al. 2004, Morrison et al. 2006, Baerwald et al. 2008), including the infectious diseases ISAV, IHNV, VHSV, *Aeromonas salmonicida*, Amoebic gill disease, salmon louse, and others. A wealth of microarray studies also exist for toxicant responses in fish (e.g. Finn et al. 2007, Tilton et al. 2006, Hook et al. 2006) for a diverse array of chemicals, including PBDE (flame retardant), endocrine disrupting compounds, heavy metals, PCB's, and others. In our own research, we also have data from both wild fish and controlled laboratory studies that assesses responses to shifting salinities and temperature, and we have assessed wild salmon in the ocean at the same time of the year as the fish from this study (the first winter at sea), some even from the west coast. We will use these studies as a backdrop to assess the possible correlation of signatures emanating from jaundiced Chinook salmon with signatures associated with pathogenic disease, toxicant exposure and other environmental stressors. To do this, we will use the recently developed meta-analysis program for microarray data GEMMA



(<http://www.chibi.ubc.ca/maintenance.html>), developed from our colleague and collaborator on our wild salmon studies, Paul Pavlidis. The literature mining software available within PathwayStudio will be similarly applied.

Because the farm site most affected by the jaundice-related disease also contains the lowest salinities of all the farm sites, we will additionally address the potential role that osmoregulatory dysfunction may play in the manifestation of this disease. We will assess the osmoregulatory state of fish in each treatment through quantitative PCR of gill cDNA for the isoforms of Na⁺ K⁺-ATPase, cold-inducible RNA binding protein, prolactin, and growth hormone. We will also determine osmolality and ion concentrations in blood plasma, which will indicate whether fish are able to maintain homeostasis in their gills.

We will evaluate health records collected and environmental data collected for the last seven years for the farm where the jaundice is most prevalent. Similar data will also be collected from one other farm where jaundice has not been observed or has been observed at very low prevalence. Health data is collected twice a week over the duration that the fish are at sea (~18-20mos). Environmental data (temperature, salinity and dissolved oxygen) is collected on a daily basis. The data will encompass 3 different generations stocked on the farm. These records will be used to estimate prevalence and describe the pattern of the disease both temporally (i.e. time of onset, age of onset, duration of disease, environmental profile) and spatially (difference in prevalence between years, between pens, between farm sites). This will be the first epidemiological analysis of this condition.

References:

- Baerwald MR, Welsh AB, Hedrick RP, May B. 2008 Discovery of genes implicated in whirling disease infection and resistance in rainbow trout using genome-wide expression profiling. *BMC genomics*;9:37.
- Evans, TG, E Hammill, K Kaukinen, AD Schulze, DA Patterson, KK English, JMR Curtis, KM Miller. Transcriptomics of environmental acclimation and survival in wild adult Pacific sockeye salmon (*Oncorhynchus nerka*) during spawning migration. *Molecular Ecology*: In Review.
- Finne EF, Cooper GA, Koop BF, Hylland K, Tollefsen KE. 2007. Toxicogenomic responses in rainbow trout (*Oncorhynchus*. *Aquatic Toxicology* 81:293-303.
- Hook, SE, AD Skillman, JS Small, IR Schultz. 2006. Gene expression patterns in rainbow trout, *Oncorhynchus mykiss*, exposed to a suite of model toxicants. *Aquatic Toxicology* 77: 372-385.
- Kent, M.L. and T.T. Poppe. *Diseases of seawater netpen-reared salmonids* Pacific Biological Station Press, Nanaimo, British Columbia, Canada (1998): 138 pp.
- Miller, K.M., Li, S, Kaukinen, K.H., Ginther, N., Hammill, B., Curtis, J.M.R., Patterson, D.A., Sierocinski, T., Donnison, L., Pavlidis, P., Hinch, S.G., Hruska, K.A., Cooke, S.J., English, K.K., and Farrell, A.P. Genomic signatures predict migration and spawning failure in wild Canadian salmon. *Science*: 331: 214-218.
- Miller, KM, AD Schulze, N Ginther, S Li, DA Patterson, AP Farrell, SG Hinch. 2009. Salmon Spawning Migration: Metabolic Shifts and Environmental Triggers. *Comp. Biochem Physiol D* 4: 75-89.
- Miller, K.M., G. Traxler, K.H. Kaukinen, S. Li, J. Richard and N. Ginther. 2007. A cDNA microarray study of Atlantic salmon (*Salmo salar*) response to Infectious Hematopoietic Necrosis (IHN) virus. *Aquaculture* 272 (Supplement 1): S217-S237.
- Morrison RN, Cooper Ga, Koop BF, et al. 2006 Transcriptome profiling the gills of amoebic gill disease (AGD)-affected Atlantic salmon (*Salmo salar* L.): a role for tumor suppressor p53 in AGD pathogenesis? *Physiological genomics* 26(1):15-34.



Rise ML, Jones SR, Brown GD, et al. 2004 Microarray analyses identify molecular biomarkers of Atlantic salmon macrophage and hematopoietic kidney response to *Piscirickettsia salmonis* infection. *Physiological genomics* 20(1):21-35.

Tilton* SC, Givan† Sa, Pereira‡,§ CB, Bailey*,‡ GS, Williams*,‡ DE. 2006 Toxicogenomic profiling of the hepatic tumor promoters indole-3-carbinol, 17beta-estradiol and beta-naphthoflavone in rainbow trout. *Toxicological* 90(1):61-72.

7. Description of how this project meets the goals, objectives and priorities of the program
(maximum length 1 page)

This project meets three of the four goals of the ACRDP program. It provides **improved competitiveness of the Canadian aquaculture industry** by providing scientific information that may be used to manage or mitigate disease impacts on aquaculture production. It provides **increased collaboration between the department and industry on scientific research and development** by using genomic technology and expertise available within the department to help resolve issues impacting the industry. It also **increases the scientific capacity for essential aquaculture research** by employing a technology that has yet to be fully realized by the salmon farming community in BC.

The research project addresses priority research within two of the broad research and development objectives: **Optimal fish health** and **Industry environmental performance**. By assessing the potential involvement of pathogen-driven versus environmentally-induced factors in the jaundice-associated disease, the project assesses the potential role of biological **causative agents** associated with disease and the **influence of the environment**. Moreover the findings of this project could impact **health management** strategies and lead to better tools for **disease surveillance and detection**.

8. Detailed deliverables of project (must include final project report)

- I. Collections of tissues from jaundiced and healthy fish that can be used for transcriptional studies and pathogen isolation and sequencing in future
- II. Full functional genomics assessment of jaundiced fish, including the lists of genes and biological processes differentially regulated in response to the jaundice-associated disease and an assessment of the potential roles of pathogens versus environmental perturbations in eliciting the disease.
- III. A list of genes that might be useful biomarkers to predict disease and stage disease progression
- IV. Characterization of osmoregulatory state of fish at the two farm-sites through biomarker screening of gill tissue and plasma ion and osmolality levels
- V. Epidemiological analysis of the disease prevalence at each of the farm sites over the past 7 years and environmental data
- VI. Recommendations to industry on next step research to either identify an infective agent associated with the disease or to narrow down potential environmental factors involved.



- VII. Manuscript to be published in a peer-reviewed journal describing results (will not be complete until after the project ends)
- VIII. Final project report to ACRDP

9. Milestones and timelines

	Pre-study																
	F	M	A	M	J	J	A	S	O	N	D	J	F	M			
Collect tissues from jaundiced and healthy fish																	
Collect tissues from smolts																	
Histological analysis of tissues																	
Epidemiological research																	
Extraction of RNA																	
qPCR of osmoregulatory biomarkers																	
Microarray Experiment																	
Data analysis and interpretation																	
Final Report																	

10. Organisation profile (maximum length ½ page)

Creative Salmon, established in 1990, is one of only a few premium growers of Chinook salmon in Canada and the world. The company's six saltwater tenures are located in the traditional territory of the Tla-o-qui-aht First Nations. Creative Salmon and its staff are active and enthusiastic community partners.

Creative Salmon has a committed and dedicated workforce of approximately 55 full time staff – and these employees are crucial to the company's continued success. The company bases its production management on organic principles, including: a low density, low-stress growing environment that encourages fish health and welfare; close contact between staff fish culturists/farmers and the fish they raise; and husbandry practices and standards that grow healthy, high quality salmon with a small environmental footprint.

Creative Salmon produces over [REDACTED] per annum by operating an integrated production cycle. With painstaking control of quality from egg to harvest, the company has established an enviable reputation for high quality Chinook salmon, serving the most discerning clientele throughout Canada, the USA and Japan.

11. Partner(s) profile, including contact name and information (if applicable) (maximum length ½ page)

The BC Centre for Aquatic Health Sciences (BC CAHS) is a research facility designed to fill the void in marine health research capacity in British Columbia. It was established in 2005 in Campbell River BC. BC CAHS exists to advance understanding of British Columbia's aquatic resources by addressing issues of aquatic animal health and welfare, production and aquatic food safety, thereby facilitating the economic, social and environmental sustainability of British Columbia's aquatic based resource industries and increasing research and service capacity in rural and coastal communities. The strength of the facility has been the success that BC CAHS researchers have had in liaising with the appropriate government and academic researchers to facilitate research important for the environment and the continued sustainability of our aquatic based resource industries.

Canada



In addition to being the [REDACTED]
operates a private practice and has been providing veterinary services to Creative Salmon for the
last 4 years.

Estimated budget – provide details of each budget item, a budget summary for each fiscal year, if
applicable, and a total project budget summary.

**Aquaculture Collaborative Research and Development Program (ACRDP)****Budget Summary by Fiscal Year 2011 (1 April – 31 March)**

Please provide a budget for the total project with each fiscal year detailed on separate attached sheets. Details for each of the line items should also be documented on separate sheets.

Description	Industry Cash Contribution	Industry In-kind Contribution	ACRDP Contribution	DFO In-kind Contribution	Partner In-kind Contribution ¹	Total
Salary						
Scientist- Millar				4,000		4,000
Veterinarian-						
Biologist						
Technicians/Biologist						
Post-Doc / Students						0
Divers		5,000				5,000
Sub-total						0
Equipment						0
Computer Equipment						0
Lab Equipment						0
Field Equipment						0
Other						0
Sub-Total						0
Material and Supplies						0
Lab		1,000	29,120			30,120
Field			510		150	460
Publication costs			500			400
Healthy Fish		1,500				0
Sub-Total						0
Travel						0
Field		2,100				2,100
Meetings						
Conferences						0
Other						0
Sub-Total						0
Other						0
Administrative						0
Facilities						0
Other expenses						0
Sub-Total						0
Grand Total		16,200	72,758	4,000		95,280
% OF CONTRIBUTIONS	0.082	0.223				0.305

Canada



Details of expenditures:

Salaries

Salary for ½ year of a BI-02 (Karia Kaukinen) in the molecular genetics laboratory who will be responsible for project management and reporting, RNA extractions, biomarker qPCR, microarray experiment, and preliminary data analysis provided by ACRDP. Karia's salary is [REDACTED]. The industry will provide a cash contribution for [REDACTED] of these salary dollars.

Dr. Miller will dedicate [REDACTED] of her time to the project, at an in kind cost of \$4,000. Most of this time will be spent on data analysis and interpretation.

[REDACTED] will provide veterinary visits and help in sample collection for the project as well as conduct the epidemiological evaluation of the condition. Expense 13 days @ [REDACTED] 4 days @ [REDACTED] for field and data collection to be covered By Creative Salmon. This expense will be covered by Creative Salmon.

7 days @ [REDACTED] to conduct the epidemiological analysis funding which is requested from ACRDP.

4 (1/2 days) [REDACTED] to attend meetings with DFO collaborators will be provided by BC CAHS as an in-kind contribution.

Fish Health Technician ([REDACTED]) to provide assistance in field - 4 days @ [REDACTED] = [REDACTED] and Biologist ([REDACTED]) will be involved in data assembly for the epidemiological evaluation -3 days @ [REDACTED] to assist in data collection. These people are employed by Creative Salmon and their time will be provided as in-kind contribution.
Total = \$2,150

Commercial Contract Divers will be used to collect samples 5 days @ \$1000/day = \$5000. This will be provided as an in-kind contribution from Creative Salmon

Equipment

Lab

Technology platforms and lab infrastructure are already in place in the **DFO Molecular Genetics Laboratory (MGL)** at the Pacific Biological Station for experimental microarray research. Dr. Miller is the Head of this laboratory, and in 2004, began developing a functional genomics laboratory for gene expression research. Current infrastructure for functional genomics research includes: Retsch MM301 mixer mill, Beckman Biomek NX^P Robot with a Span-8 Head and Integrated DTX 880 Plate Reader, TECAN HS 4800 Pro Hybridization Station with two extension units (24 slides/day capability and potential to expand to 4 extension units with 48 slide/day capability), Packard BioScience ScanArray Express Microarray Scanner, MJ Research PTC 100 PCR machines, Millipore MilliQ Biocel Water Purification System, ABI 7900HT Fast Real-Time PCR System and Integrated Carousel (384 well plate platform). The MGL is built for high throughput experimental research and application, and easily contains the capacity to carry out the proposed study. *No funding is being requested for use of this equipment.*

Field



Field supplies including formalin, histology cassettes, tools (forcep, scalpels, scissors etc) will be provided in kind by BC CAHS - value \$150
Blood collection materials and RNAlater \$510

Materials and Supplies

Creative salmon is donating 30 healthy fish to the project at a market value of \$1,500. As the brains will be removed, these fish will not be saleable.

Lab

Histology $75 \times \$32/\text{sample} = \$2,400$ Creative salmon will provide \$1,000 as an in-kind contribution.

Plasma ion and osmolality will be conducted in David Patterson's lab. $60 \text{ samples} \times \$12/\text{sample} = \$720$

Biomarker study $60 \text{ fish} \times 10 \text{ biomarkers (including housekeeping genes)} \times \$5/\text{biomarker} = \$3,000$

Microarray Study: Each array costs a total (excluding labour) of \$400 to run, which includes the slide costs (\$160 per array within the 44K slide), RNA extractions, amplification, labeling, and hybridization costs, as well as a portion of the service contract on the Tecan hybridization robot and the Tecan robotic slide reader. There is also a built in 5% margin to accommodate slides that have to be re-run. Microarray study $60 \text{ fish} \times 400/\text{array} = \$24,000$

Publication costs

\$500 will cover the cost of publishing a manuscript with one colour figure.

Travel

Collaborative Meetings travel CAHS-DFO \$400 for 5 trips/year

Field Travel CAHS-Tofino for sample collections \$1500 for 4 trips (600km @ \$.50/km per trip + accommodation (if required)+food), industry in-kind contribution

Boat Travel for sample collection \$600 for 4 trips (\$150/day), industry in-kind contribution.

1. If more than one partner, please provide details of contribution from each one.

P11-02-007

July 5th, 2011

c: [REDACTED]
Judy Volk

[REDACTED]
K. Kaukinen

DFO-51510-841-121-53248
CANADA - Creative Salmon Ltd.
SM 51510-841-760-57440 COLLABORATIVE AGREEMENT

THIS AGREEMENT is made in duplicate as of June 6th, 2011.

Between: **HER MAJESTY the Queen in right of Canada ("Canada")**, as represented by the Minister of Fisheries and Oceans on behalf of Science in the Pacific Region ("DFO").

And: **Creative Salmon Ltd.**, a corporation incorporated under the laws of British Columbia, with a head office located at PO Box 265 Tofino in the province of British Columbia (the "Organization").

RECITALS

WHEREAS Canada and the Organization (each shall be referred to as "Party" and together they shall be referred to as "Parties") wish to collaborate under the Aquaculture Collaborative Research and Development Program (ACRDP) on the research project "**Genomic characterization of jaundice-associated mortality events in cultured Chinook salmon**" described in Appendix A hereto (the "Project"); and

WHEREAS the Organization and DFO have a joint interest in the expected outcome of this collaboration and have shared or compatible objectives associated with the Project; and

WHEREAS the Organization and DFO are both expected to provide financial and/or in-kind resources towards the Project in accordance with their relative vested interest in the Project and understand that in-kind resources provided for the Project shall be evaluated at cost; and

WHEREAS the Organization and DFO agree to a fair allocation of risk, demonstrated through the development of a governance framework on decision making, accountability, and risk mitigation related to the Project; and

WHEREAS this Agreement is neither a procurement agreement pursuant to the Government Contracts Regulations, nor a transfer payment agreement pursuant to the Treasury Board Transfer Payments Policy.

THEREFORE, the Parties agree as follows:

1. Definitions

- a) "**Agreement**" means the recitals, definitions, terms, conditions and obligations stipulated herein including the stipulations in the appendices affixed hereto.
- b) "**Contribution**" means resources that are given/provided/supplied by a Party toward the Project. The term should not be confused with a Government of Canada Contribution, as per the Treasury Board Transfer Payments Policy.
- c) "**Intellectual Property**" or "**IP**" means any invention, and any other product of intellectual activity in the industrial, scientific, literary, or artistic fields including all intellectual creation

legally protected through patents, copyright, industrial design, integrated circuit topography, and plant breeders' rights, or subject to protection under the law as trade secrets and confidential information.

- d) **"Project Expenditures"** means expenditures required for the Project, which are described and itemized in Appendix B of the Agreement.
- e) **"Research IP"** means IP arising from research and other activities performed under this Agreement, and any parts of such IP.
- f) **"Crown"** means the Federal Government of Canada.
- g) **"Work Plan"** means the detailed activities and corresponding resources required to implement the Project in accordance with the Project description provided in Appendix A.
- h) **"Project Manager"** means the person with authority to manage the Project and lead the planning and the development of all Project deliverables.

2. Duration of the Agreement

- a) The Agreement shall be effective as of the date of signature and shall expire, unless terminated sooner in accordance with article 15 of this Agreement on July 31st, 2012.

3. Purpose of the Collaboration

The ACRDP directly supports DFO's Program for Sustainable Aquaculture, which reflects the federal government's commitment to increase scientific knowledge to support decision-making, strengthen measures to protect human health, and make the federal legislative and regulatory framework more responsive to the public and to the Aquaculture industry needs. The purpose and expected deliverables of the Project are described in Appendix A.

4. DFO's Contribution

- a) DFO's contribution to the Project, estimated at \$76,758 represents the resources that DFO will provide to the Project as outlined in Appendix B.
- b) DFO contributes to the Project as follows:

Fiscal Year	Total value	List of DFO In-kind Contributions
2011-12	\$76,758	Staff time, travel, lab supplies

5. Organization's Financial and/or In-kind Contribution

- a) The Organization's contribution (financial and/or in-kind) to the Project, estimated at \$22,200 represents the resources that the Organization will provide to the Project as outlined in Appendix B.

- b) The Organization contributes to the Project as follows:

Fiscal Year	Total value	Financial Contribution	List of In-kind Contribution
2011-12	\$22,200	\$6,000	Staff time, travel, lab supplies

- c) The Organization shall make its financial contribution for the Project according to the payment schedule below:

Payment Amount	List of Deliverables	Estimated Date of Payment
\$6,000	Collections of tissues from jaundiced and healthy fish that can be used for transcriptional studies and pathogen isolation and sequencing in future Full functional genomics assessment of jaundiced fish, including the lists of genes and biological processes differentially regulated in response to the jaundice associated disease and an assessment of the potential roles of pathogens versus environmental perturbations in eliciting the disease.	June 15, 2011

- d) Amounts received by DFO under the Agreement will be deposited into a "Specified Purpose Account" ("Account") and used to pay for Project Expenditures. DFO shall not incur any Project Expenditures unless the Account contains enough funds to pay for such Project Expenditures. DFO will notify the Organization thirty (30) days in advance if it believes that funds remaining in the Account are not sufficient to cover anticipated Project Expenditures and the Organization shall provide funds in advance of the payment schedule herein.
- e) Project Expenditures for the supply of contracted goods and services to carry out the Agreement are subject to the Goods and Services Tax (GST) or the Harmonized Sales Tax (HST) as applicable.
- f) At the end of the Project or upon earlier termination of the Agreement, DFO will return to the Organization any money remaining in the Account after all monetary obligations in relation to the Project have been satisfied, unless the remaining amount is less than \$100 in which case the remaining funds will be credited to the CROWN as miscellaneous revenue.
- g) Throughout the Project and for two years after expiration or termination of the Agreement, the Organization may request access to DFO records related to Project Expenditures and DFO shall provide reasonable facilities and co-operation to allow the Organization to review these records and to take copies, as required.
- h) All payments shall be made payable to the Receiver General for Canada and delivered to DFO Finance:

Fisheries and Oceans Canada
Revenue Unit
Suite 200 – 401 Burrard Street
Vancouver, BC V6C 3S4

6. Risk Management

- a) The Project Authorities as identified in section 7(b) of the Agreement have discussed and completed a risk assessment and analysis as per Appendix D of the Agreement.

7. Project Authorities

- a) The Project shall be managed jointly, with each party separately administering its responsibilities under the Project. Each Party shall name a Project Authority to oversee the management and administration of its responsibilities with respect to the Project. The Project Authorities may call upon such other persons for assistance as they consider necessary.
- b) The Project Authority for DFO shall be:

Karia Kaukinen, MSc
Molecular Genetics,
Fisheries and Oceans Canada
Pacific Biological Station
3190 Hammond Bay Rd
Nanaimo, BC V9T 6N7
250 759-8358
Karia.Kaukinen@dfo-mpo.gc.ca

and the Project Authority for the Organization shall be:

[REDACTED]
Creative Salmon Company Ltd.
PO Box 265
Tofino, BC VOR 2Z0
250-725-2884
[REDACTED]

- c) Either Party may by notice request a change of address, or designate a new Project Authority.

8. Monitoring and Evaluation

- a) The Parties shall ensure that the Project Authorities:
 - i) monitor the progress of the Project and performance of the Parties under the Annual Work Plan; and
 - ii) verify that Project Expenditures are consistent with anticipated Project costs and deliverables, as described in the Work Plan.

9. Access to DFO Grounds and Buildings

- a) The Organization, its employees and its agents involved in the Project shall abide by all orders and policies with respect to access to DFO sites, vessels and buildings and utilization of facilities therein, including orders and policies related to security, health and safety, and shall not bring any people, equipment or any materials into these buildings without the prior written consent of the DFO Project Manager.

10. Reports and notices

- a) Each party shall report to the other on the progress of the research it is performing under the Project and any on scientific results and data arising from such research. Reports shall be provided at a reasonable frequency and at a minimum once annually to ensure that the Parties remain well informed and up-to-date on the Project. Each Party shall also provide to the other within Three (3) months from the termination or the end of the Project a final report on all the research it has performed under the Project, including the scientific results and data acquired from the research, and a summary of Project costs it has incurred. In addition, the Parties will cooperate to complete a final evaluation report for the entire Project within Three (3) months following the end of the Project, using the template provided in Appendix E, on the understanding that the DFO Project Authority will submit the report to the DFO ACRDP Regional Coordinator.
- b) If requested, the Organization shall assist the DFO Project Authority in preparing a fact sheet outlining the Project, the Project research methodology, and the Project results. It is agreed and understood that the final evaluation report may be used to develop the fact sheet, which DFO may publish on the DFO website as well as in hard-copy.
- c) Notices, reports and other communications under the Agreement shall be in writing and shall be addressed to the Project Authorities.

11. Intellectual Property

- a) Each Party shall promptly disclose to the other any technology, data or other information in its possession, required by the other Party to perform any Project activities for which it is responsible. Each Party remains the owner of technology, data or information that it owned prior to disclosure to the other Party and such technology; data or information shall be subject to the confidentiality provisions of Appendix C.
- b) Research IP is subject to the provisions of Appendix C.

12. Ownership of Biological Material and Equipment

- a) Any equipment and material, including animals, biological material and organisms arising, acquired, and produced under this Agreement belong to the Minister.
- b) Animals and biological material provided by the Organization for the Project and biological products issued therefrom, as defined in Appendix F of the Agreement shall be subject to the provisions of Appendix F.

13. Dispute Resolution

- a) If any dispute, other than a matter of public law arises between the Parties in connection with or arising out of the Agreement, the Parties shall use their best efforts to settle any such dispute by negotiations or mediation. If the Parties fail to resolve the dispute within a period of thirty (30) days or such greater period as may be mutually agreed, then either Party may refer the dispute to arbitration in accordance with the *Canadian Commercial Arbitration Act*. The location for the arbitration hearing shall be Nanaimo, BC.

14. Liabilities

- a) Under no circumstances will Canada and its Ministers, officers, and employees incur any obligation or liability whatsoever for any death, injury, loss, damages, or expenses arising in any way, including gross negligence, in relation to the performance of the Agreement. Sole risk in this respect shall be borne by the Organization.
- b) The Organization shall indemnify and save harmless Canada and its Ministers, officers and employees from and against and be responsible for all claims, demands, losses, costs, damages, actions, suits or proceedings by whomever made, brought and prosecuted in any manner, based upon, arising out of, related to, occasioned by, or attributed to any acts or conduct of the Organization, its employees or agents relating to the Agreement unless such claims, suits, actions or demands result from injury, loss or damage caused by the negligence of a DFO employee acting within the scope of his employment

15. Termination

- a) DFO may terminate the Agreement upon thirty (30) days notice to the Organization, if:
 - i) the Organization breaches any terms or conditions of the Agreement and does not remedy any such breach within thirty (30) days after being notified of the breach in writing by DFO; or
 - ii) The Organization is not conducting the Project in accordance with the Work Plan and does not rectify the matter within thirty (30) days after being notified in writing of the specific rectifications required to remedy the execution of the Project; or
 - iii) the Organization is insolvent, in receivership, bankrupt, files for bankruptcy, or is involved in any act of bankruptcy or any bankruptcy proceeding; or
 - iv) the Organization is convicted of any offense under any the law, order or regulation of Canada or the provinces or of a duly constituted authority thereof or the conditions of any license, or of being an accessory to any such offence, and if such offence is committed in connection with the Agreement; or
 - v) the Organization has submitted false or misleading information to DFO in respect of the Project or in respect of the Organization's obligations pursuant to the Agreement; or
 - vi) DFO is unable to continue supporting the Project due to departmental priorities and/or pressures; or

- b) DFO will amend or terminate the Agreement if the resources that DFO is expected to contribute to the Project (that are subject to corresponding appropriations being approved by Parliament) are reduced or not available. In either case, the Organization hereby agrees to refrain from taking any action against DFO, DFO Minister and DFO employees for damages.
- c) The Organization may terminate this Agreement by written notice to DFO if DFO is not conducting the Project in accordance with Appendix A and does not rectify the matter within thirty (30) days after being notified in writing of the specific rectifications required to the Project.
- d) If the Organization wishes to terminate the Agreement for any reason other than the one set out in paragraph (b), the Organization shall deliver to DFO a written request to terminate the Agreement and upon DFO receiving such a request DFO will deliver to the Organization a notice confirming any outstanding obligations, including financial obligations, under the Agreement and may terminate the Project and the Agreement if:
 - i) the Organization satisfies all its obligations and pays to DFO any amount required towards Project Expenditures that DFO is unable to suspend;
 - ii) ending the Project would not have a significant adverse effect on DFO; and
 - iii) the Organization is in full compliance with the terms of the Agreement.
- e) Expiration or termination of the Agreement shall not relieve the Organization from its obligations in respect of Intellectual Property, Publications and Confidentiality as set out in Appendix C to this Agreement.
- f) Failure by DFO to notify the Organization of a breach of the Agreement or to terminate the Agreement because of such breach shall not constitute an acceptance of the breach or a waiver of the right of DFO to terminate this Agreement in accordance with its provisions, and to recover any sums due to DFO under the Agreement.

16. Canadian Environmental Assessment Act (CEAA)

- a) The Organization and DFO shall ensure that, if applicable, the Project is assessed and approved in accordance with the Canadian Environmental Assessment Act prior to commencing the Project.

17. Canadian Council on Animal Care (CCAC)

- a) The Organization and DFO shall ensure that, if applicable, the Project is assessed and approved in accordance with the standards of the Canadian Council on Animal Care (CCAC). DFO will contact its Animal Care Committee to ensure compliance with this provision prior to commencing the Project.

18. General

- a) **Entire Agreement**

The Agreement, which includes the Appendices appended thereto and which are part thereof, sets

forth the entire agreement between the Parties hereto concerning the subject matter hereof and supersedes and revokes all negotiations, arrangements or communications, of any nature whatsoever whether they be verbal or in writing, between the Parties or their authorized representatives or any other person purporting to represent DFO or the Organization.

b) No Agency

Nothing contained in the Agreement shall be considered or construed as creating the relationship of partners, principal and agent, lessor and lessee, licensor and licensee (except with respect to Research IP, in accordance with Appendix C to the Agreement) or of employer and employee between the Parties. In particular, the Organization agrees to be solely responsible for any and all payments and/or deductions required to be made including those required for Canada Pension Plan, Employment Insurance, Workers' Compensation, or Income Tax for all its employees involved in the Project. The Organization shall be solely responsible for the supervision, scheduling of work and tasking for its employees and agents engaged by or on behalf of the Organization for the Project.

c) House of Commons

No member of the House of Commons shall be admitted to any share or part of the Agreement or to any benefit that may arise from it.

d) Public Servants

No former public office holder who is not in compliance with the post employment provisions of the Values and Ethics Code for the Public Service shall derive a direct benefit from the Agreement.

e) Laws in force

The Agreement shall be interpreted in accordance with federal laws of Canada and the laws in force in the Province of British Columbia.

f) Location

The Project shall be performed at Pacific Biological Station 3190 Hammond Bay Rd , Nanaimo , in the Province of British Columbia.

g) Amendment

This agreement may only be amended by a written amendment signed by the Parties' authorized representative at any time during the term of this Agreement.

h) Severability

Should a court of competent jurisdiction hold that any provision of the Agreement is invalid, illegal, or unenforceable, such provision shall be considered severed from the Agreement and all other provisions of the Agreement, and all rights and obligations therein shall continue to be in force and effect.

i) **No Assignment**

Neither Party may assign the Agreement, in whole or in part, without the prior written consent of the other Party(s).

j) **Official Languages**

- i) The Agreement was prepared in English at the request of the organization; and
- ii) All announcements and communications to the public concerning the Project or this collaboration shall be made in both official languages.

k) **Lobbyist Registration Act**

Any person lobbying on behalf of the Organization must be registered pursuant to the *Lobbyist Registration Act*.

l) **Time of Essence**

Time is of the essence with respect to all deliverables under the Agreement.

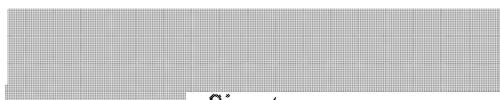
m) **Order of Precedence**

If there is a conflict of ambiguity between this Agreement proper and any appendices or schedules thereto, this Agreement proper shall prevail.

IN WITNESS WHEREOF the Agreement has been executed by DFO and the Organization through their duly authorized officers.

The Organization:

**Her Majesty the Queen in Right of
Canada, as represented by the Minister
of Fisheries and Oceans.**


Signature

Name & Title of Organization's
authorized representative

JUNE 10, 2011

Date



Signature
JUN - 8 2011

Dr. Laura J. Richards
Regional Director Science

Date

Appendix A: Project Description / Work Plan

Observed with unique clinical presentation, the salmon present with mild to severe yellow discolouration of the skin (jaundice). This is most evident on the abdomen and around the eyes. These fish also have very pale gills indicating anemia. Internal signs include pale livers and often the stomachs of the fish are empty indicating the fish have not eaten for a number of days although the overall condition of the fish is good. Grossly the other organs appear unaffected. The clinical presentation is very different from Marine Anemia syndrome, another Chinook salmon disease, which typically presents with splenomegaly, renomegaly, and anemia.

Histological examination has found severe liver and kidney damage (hydropic degeneration). The proposed etiology includes a pathogen or exposure to a negative environmental influence (hereafter referred to as an undefined toxin). Repeated testing using traditional diagnostic tests have been unable to identify a pathogen. Tests including classical bacterial culture, viral cell culture, PCR, blood assessment and histopathology have yielded negative results for pathogens including *Renibacterium salmoninarum* (BKD), *Listinella* sp (vibriosis), VHSV, IHNV, ISAV, VEN, EIBS, *Loma salmonae*, and *Nucleospora salmonis* (marine anemia).

Little is known of the epidemiology of the condition. It affects fish that have been in sea water for greater than 6 months and therefore is not considered related to smolt quality. There appears to be a seasonal pattern to this condition with clinical signs and mortalities observed late fall/early winter (December) spiking in the winter and apparently resolving by early summer.

This condition is most typically observed at the farm site operated by Creative Salmon that contains the greatest freshwater influence, which is one reason to suspect an environmental effect may be at play, although it is sometimes observed at relatively lower incidence levels at other farm sites. It has been seen in most of the generations stocked at the freshwater-influenced farm even though the company operates single year class sites with a fallow period before re-stocking. At the most affected farm most often one or two pens of fish are severely affected, however the condition may be seen in many of the pens. The mortalities levels in most heavily affected pens typically would be several folds higher than the other pens on the farm. For example in January 2011, the single affected pen (of an 8 pen site) disproportionately made up 35% of the mortalities grossly examined. Of the mortalities examined from this single pen over 77% of the fish examined exhibited jaundice. Total mortality attributed to this condition has not been fully assessed although at certain times of the year it can be as significant as other diseases.

Currently there are no tools available to manage the problem. A better understanding of the epidemiology and etiology would enable us to develop these tools.

Project objectives

Our main objective is to apply functional genomics technology to gain a better understanding of the factors that may underlie the poorly understood jaundice-related disease experienced by farmed Chinook salmon in Tofino. Of most import, Creative Salmon managers need to know whether this disease is more likely the result of an infectious agent or environmental conditions.

If the genomic signature indicates that an infective agent is likely involved, they will pursue the identification of this agent through 454 sequencing of affected tissues in a follow up study. If the

genomic signature is more likely associated with environmental conditions at this farm site, e.g. low salinity, toxicants, or other factors, follow-up studies could be performed to assess the most likely environmental mechanisms. In either case, knowledge of the mechanisms leading to this disease will potentially provide managers with tools to track, predict, and/or potentially mitigate the impact of this disease in future.

Our other objective is to improve our understanding of the epidemiology of the condition – why is the condition more prevalent at one farm as compared to the others in the same area, or in some pens and not others? This would include examining the mortality pattern, and determining overall mortality attributed the condition, and the environmental factors associated with it.

Description of work and experimental protocol

Fish on Creative Salmon's farms are regularly screened for health, and the presence of jaundice is one of the metrics that is tracked bi-weekly in each net pen at each site. While mild jaundice can occur to some degree at all sites, jaundice-related mortality is predominant at the farm with the greatest freshwater influence. Despite extensive histological study, we still do not understand whether the jaundice may result from an infective agent or may be a manifestation of environmental conditions, possibly relating to low salinities, in the winter, or a combination of both. Hence, we need to design an experiment that considers both possibilities.

The molecular genetics laboratory has successfully used microarray approaches on wild fish to assess unknown factors associated with poor performance (e.g. Miller et al. 2010) and transcriptional responses to shifting environments (Miller et al. 2009; Evans et al. In Review).

We have also conducted microarray studies of host response to disease (Miller et al. 2007; IHNV) and have conducted studies with Peter Ross at IOS on the influence of toxicant exposure on immune response to *Vibrio* (data still in preparation for publication). Moreover, we have been working closely with a bioinformatics group at UBC, lead by Dr. Paul Pavlidis, on the development of meta-analysis tools to identify correlated profiles among microarray experiments. Hence, we have the experience and expertise to undertake this exploratory study.

We will use similar experimental designs and approaches as we have used in previous studies (e.g. Miller et al. 2009) whereby we apply balanced replication across each biological variable, or treatment, of interest. Here, treatments are not really treatments, as one would define in a controlled laboratory study, but rather biologically meaningful entities, like sample sites, disease state, and life-history stage.

Approach: If an infective agent is involved, it is important to determine whether it is present in smolts used to stock the farm sites, or whether it likely emanates from the marine environment. As such, our study will include smolts used to stock net pens in 2011 (Treatment 1; note that the sample size of smolts would only detect positives that affected 10% or more of fish, so it is not an exhaustive, definitive assessment of the role of freshwater). To control for the environment, we will contrast apparently healthy (no evidence of jaundice) fish a farm that is not substantively affected by jaundice (Treatment 2) with healthiest fish that can be obtained sampled from the affected freshwater-influenced farm (Treatment 3). To obtain healthy fish, we will chum fish from netpens that have been shown to have the lowest levels of jaundice and conduct histological analyses to ascertain their state of health. Fish that were collected in this manner but deemed to be positive for,

but not dying of, jaundice at the time of collection will also be included in the analysis to control for the effects of morbidity (Treatment 4). Finally, moribund fish with clear evidence of jaundice will be included in the study (Treatment 5). Multiple tissues from all collected fish will be examined histologically.

Head and Posterior kidney, spleen, liver, heart, muscle, gill, and blood of 10-15 fish will be collected for each "treatment" category.

I. Smolts

II. Healthy fish from unaffected farm at mouth of the inlet

III. Healthy fish from affected farm

IV. Fish with histological signature of jaundice but not moribund at affected farm

V. Moribund fish with histological signature of jaundice at affected farm In anticipation of this study, some of the samples of moribund and jaundiced fish were collected during a mortality event at the end of February 2011. Additional samples of jaundiced but not moribund and healthy fish from both farm sites will be collected in early March, along with additional moribund and jaundiced fish, if still present. Smolts will be collected in April before they are put to sea.

The microarray study will be performed on cDNA from liver tissue, as liver is one of the most severely affected organs and is also the primary tissue for detoxification. We will keep the remaining tissues for potential future study. In a balanced experimental design, twelve biological replicates (individuals) will be included for each of the five treatments, with the total study comprising 60 arrays. The Salmonid Agilent 4x44K oligonucleotide arrays developed through the cGRASP program by Ben Koop's laboratory at University of Victoria will be used in the study, with approaches similar to those we have used in other studies (e.g. Miller et al 2009, 2011). A reference sample comprised of liver cDNA from all of the individuals used in the study (labelled with Alexa555) will be hybridized along with the experimental sample (labelled with Alexa647) on each array. After slide quality assessment and Lowess normalization, arrays will be statistically analysed using both supervised (multifactorial ANOVA with posthoc testing via Mann Whitney U t-test) and unsupervised (Principle Component Analysis) approaches to identify transcriptional differences among treatments and the main physiological trajectories in the data. Functional analysis of the biological processes over-represented among the differentially regulated genes will be determined using the programs DAVID (<http://niaid.abcc.ncifcrf.gov/>) and PathwayStudio (Ariadne Genomics). Further information on the functional role of the most significantly differentially regulated genes will be gleaned from the protein literature mining website iHop (<http://www.iHop-net.org/UniPub/iHOP/>). Many salmon diseases have already been characterized by microarrays (e.g. Miller et al. 2007, Rise et al. 2004, Morrison et al. 2006, Baerwald et al. 2008), including the infectious diseases ISAV, IHNV, VHSV, *Aeromonas salmonicida*, Amoebic gill disease, salmon louse, and others. A wealth of microarray studies also exist for toxicant responses in fish (e.g. Finn et al. 2007, Tilton et al. 2006, Hook et al. 2006) for a diverse array of chemicals, including PBDE (flame retardant), endocrine disrupting compounds, heavy metals, PCB's, and others. In our own research, we also have data from both wild fish and controlled laboratory studies that assesses responses to shifting salinities and temperature, and we have assessed wild salmon in the ocean at the same time of the year as the fish from this study (the first winter at sea), some even from the west coast. We will use these studies as a backdrop to assess the possible correlation of signatures emanating from

jaundiced Chinook salmon with signatures associated with pathogenic disease, toxicant exposure and other environmental stressors. To do this, we will use the recently developed meta-analysis program for microarray data GEMMA (<http://www.chibi.ubc.ca/maintenance.html>), developed from our colleague and collaborator on our wild salmon studies, Paul Pavlidis. The literature mining software available within PathwayStudio will be similarly applied.

Because the farm site most affected by the jaundice-related disease also contains the lowest salinities of all the farm sites, we will additionally address the potential role that osmoregulatory dysfunction may play in the manifestation of this disease. We will assess the osmoregulatory state of fish in each treatment through quantitative PCR of gill cDNA for the isoforms of Na⁺ K⁺-ATPase, cold-inducible RNA binding protein, prolactin, and growth hormone. We will also determine osmolality and ion concentrations in blood plasma, which will indicate whether fish are able to maintain homeostasis in their gills.

We will evaluate health records collected and environmental data collected for the last seven years for the farm where the jaundice is most prevalent. Similar data will also be collected from one other farm where jaundice has not been observed or has been observed at very low prevalence. Health data is collected twice a week over the duration that the fish are at sea (~18-20mos). Environmental data (temperature, salinity and dissolved oxygen) is collected on a daily basis. The data will encompass 3 different generations stocked on the farm. These records will be used to estimate prevalence and describe the pattern of the disease both temporally (i.e. time of onset, age of onset, duration of disease, environmental profile) and spatially (difference in prevalence between years, between pens, between farm sites). This will be the first epidemiological analysis of this condition.

Detailed deliverables

Collections of tissues from jaundiced and healthy fish that can be used for transcriptional studies and pathogen isolation and sequencing in future.

II. Full functional genomics assessment of jaundiced fish, including the lists of genes and biological processes differentially regulated in response to the jaundice associated disease and an assessment of the potential roles of pathogens versus environmental perturbations in eliciting the disease.

III. A list of genes that might be useful biomarkers to predict disease and stage disease progression

IV. Characterization of osmoregulatory state of fish at the two farm-sites through biomarker screening of gill tissue and plasma ion and osmolality levels

V. Epidemiological analysis of the disease prevalence at each of the farm sites over the past 7 years and environmental data

VI. Recommendations to industry on next step research to either identify an infective agent associated with the disease or to narrow down potential environmental factors involved.

VII. Manuscript to be published in a peer-reviewed journal describing results (will not be complete until after the project ends)

Appendix B: Project Expenditures

Budget Summary by Fiscal Year 2011-12 (1 April – 31 March)

Description	Organization		Department of Fisheries and Oceans	
	Financial Contribution	In-Kind Contribution	ACRDP Contribution	Other DFO In-Kind Contribution
Salary				
. Miller IND RES -03				4,000
Kaukinen IND BI-02				
CAHS Veterinarian-				
Equipment				
Material & Supplies	6,000			
Travel				
Facilities				
Grand Total	6,000	16,200	72,758	4,000

Salaries

Salary for ½ year of a BI-02 (Karia Kaukinen) in the molecular genetics laboratory who will be responsible for project management and reporting, RNA extractions, biomarker qPCR, microarray experiment, and preliminary data analysis provided by ACRDP. Karia's salary [redacted] per year. ([redacted] * 1.2 benefits = [redacted], funded [redacted] from industry, [redacted] from ACRDP

Dr. Miller will dedicate [redacted] of her time to the project, at an in kind cost of \$4,000. Most of this time will be spent on data analysis and interpretation

Appendix C: Intellectual Property, Confidentiality and Publication

1. Rights with respect to Research IP

- 1.1. Research IP that is created, developed or produced by DFO employees in the course of their employment, or with any intellectual contribution or direction from DFO employees shall belong to Canada, under the control and administration of the Minister. Research IP that is created, developed or produced by the other Party without any contribution or direction from DFO employees shall belong to the other Party.
- 1.2. If a Party creates, develops, or produces any Research IP such Party shall promptly disclose such Research IP to the other Party and provide to the other Party all technical information that may be necessary to enable the other Party to use the Research IP. The other Party may use the Research IP for non-commercial research purposes only, without restrictions and without any obligations to the first Party, but may not use it in any other way or disclose it to third parties without the prior written authorization from the first Party.
- 1.3. The Party collaborating with the Minister under this Agreement may request a licence from the Minister to use Canada-owned Research IP for commercial exploitation. The request shall be in writing, and delivered to the Minister no later than Three (3) months after the end of the Project. The Parties agree to negotiate in good faith the terms and conditions of a licence, however if they can't agree on the terms and conditions within Three (3) months following the beginning of licence negotiations, or at such later time as the Parties may agree, the Minister will no longer be obligated to continue negotiating a licence with the other Party.

2. Patenting of Research IP

- 2.1. The Parties shall fully cooperate with each other, and assist each other free of charge in the preparation and filing of any patent applications related to Research IP, including without limitation obtaining the necessary assistance to prepare patent applications.
- 2.2. Each Party shall promptly provide to the other a copy of every patent application that it files in relation to Research IP.
- 2.3. Each Party shall execute such conveyances or other documents as required for the filing, prosecution and maintenance of any patent applications, and for defending any issued patents related to Research IP.

3. Confidentiality

- 3.1. Any technology data or other information of any kind related to the Project (Collectively "Information") shall be deemed confidential and neither Party may release any such information to others in any way whatsoever without the prior written authorization of the other Party. However this confidentiality obligation shall not apply to the Party who owns the Intellectual Property in such Information, and in the case of DFO, this confidentiality obligation shall be subject to the access to information and privacy protection legislation, including the *Access to Information Act* and the *Privacy Act*.

- 3.2. A Party who receives confidential Information transmitted in any form by the other Party shall keep that Information confidential. However this obligations shall not apply to Information, that is or falls lawfully in the public domain, that was lawfully in the possession of the Party prior to disclosure by the other Party, or that a Party may receive from a third party not bound by any confidentiality obligations.

4. Publication and Disclosure of Information

- 4.1. If a Party ("First Party") wants to disclose any Information produced under this Agreement, other than Research IP owned by the First Party, it shall submit the information intended for disclosure to the other Party for review, at least sixty (60) days prior to the intended disclosure. The other Party will have thirty (30) days to notify the First Party in writing if such information or any portions thereof must be withheld from disclosure for patenting purposes, or for the purpose of a scientific publication. Upon being so notified the First Party may either delete from the intended disclosure the information that the other Party has requested be withheld from disclosure or withhold disclosure of such information for a reasonable time to allow the publication or the filing of a patent application. Any request to withhold disclosure for may extend for a reasonable time but not exceeding one year.

5. Term of obligation

- 5.1. The obligations of the Parties herein shall survive the expiration or termination of the Agreement to which this Appendix is affixed and of which it is part. However in respect of confidential information any confidentiality obligation shall remain in effect until such time that the information becomes public.

Appendix D: Risk Management

It is the government policy to identify and reduce or eliminate risks, minimize and contain the costs and consequences of harmful or damaging incidents arising from these risks.

http://www.tbs-sct.gc.ca/pubs_pol/dccpubs/RiskManagement/riskmanagpol_e.asp

http://www.tbs-sct.gc.ca/pubs_pol/dccpubs/RiskManagement/guide_e.asp

Project Risk Analysis						
Project Objective	Anticipated Risk Description and its Consequences	Result of likelihood and impact assessment		Risk Rating	Existing mitigation capacity or capability	Additional mitigation action or strategy
		Likelihood	Impact			
To apply functional genomics technology to gain a better understanding of the factors that may underlie the poorly understood jaundice-related disease experienced by farmed Chinook salmon in Tofino.	Those mortality events may have been already over prior to the commencement of the project and samples may not be available.	Minimal	moderate	3	We have initial outbreak samples of moribund fish from February 2011, but we plan to augment this small sample set with larger sample sets that include negative and positive controls.	None required
						Karia Kaukinen (see governance framework)

Appendix E
ACRDP Final Project Report

PART I

1. Project #:
2. Project Title:
3. Project Duration:
4. Project Leader, contact information:
5. Industry partner(s):
6. Expenditures and variance from budget:

	Contribution	Initial budget	Actual expenditure	Difference
Industry \$				
Industry (in kind)				
ACRDP (\$)				
Other DFO (\$ and in kind)				
Partners (\$ and in-kind)				

7. Expertise developed during the project (e.g., within DFO, industry, graduate students etc.):

8. General Comments:

PART II

- The following sections should be completed in a non-technical language that is suitable for an audience comprising individuals involved in the aquaculture industry.
 - Please limit the information to approximately 5 pages
-

9. Project rationale (e.g., background information, why solving the problem was of interest to industry, project hypothesis and goals):
10. Short summary of project methods (e.g., experimental and analytical procedures followed, deviations from the originally proposed methods):
11. Key results (include graphs, data tables, photos, etc. where applicable):
12. Resulting key improvements to sustainable aquaculture and scientific advancements:
13. Suggested next steps, future research/development/innovation needs:
14. Copies of publications, reports or articles produced in reference to the project:
15. Identify any invention or innovation that may have resulted from this Project, including any new process or technique.

PART III

Declaration:

I _____ have completed the report and declare that to the best of my knowledge the report is accurate.

Signature

Date

Approved by:

DFO Project Authority

Date

Industry Project Authority

Date

Appendix F

Provisions related to Biological Products

Definitions

1. "Biological Products" means animals, biological material and organisms.
2. "Biological Material" means Biological Products provided by the Organization to the Minister for the Project.
3. "Issued Biological Material" means Biological Products issued from Biological Material, and otherwise acquired, and produced under the Project.

Biological Material belongs to the Organization, and Issued Biological Material belongs to DFO

1. Issued Biological Material shall belong to the Minister.
2. Ownership of Biological Material shall remain with the Organization, and the Minister shall return such Biological Material to the Organization at the end of the Project; it is agreed and understood that the Minister shall not be responsible for the condition of any Biological Material, or for death of any animals in its possession, and will not return any deceased animals to the Organization.
3. The Organization shall not dispose of, or transfer any Biological Products returned by the Minister to the Organization without the Minister's prior written authorization, such authorization not to be unreasonably withheld. It is agreed and understood that such authorization may be withheld if the proposed disposal and transfer of the Biological Products might present an environmental risk or might jeopardize the Minister's rights and interests in any Intellectual Property relating to the Biological Products.

Parsons, Jay

From: Parsons, Jay
Sent: Friday, November 24, 2017 3:24 PM
To: Moore, Wayne
Cc: White, Andrea
Subject: RE: Summaries - 2 papers
Attachments: MECTS-#3852940-v1-2017
_EOS_SRS_ABAHS_Jaundice_in_Chinook_Salmon_on_the_west_coast_of_British_Columbia.DOCX

Importance: High

Wayne,

For your review and approval.

Jay

From: Moore, Wayne
Sent: Thursday, November 23, 2017 8:06 PM
To: McPherson, Arran; Parsons, Jay
Cc: White, Andrea
Subject: Re: Summaries - 2 papers

Of course. We live to serve :-).

Sent from my BlackBerry 10 smartphone on the Rogers network.

From: McPherson, Arran
Sent: Thursday, November 23, 2017 7:11 PM
To: Moore, Wayne; Parsons, Jay
Cc: White, Andrea
Subject: Summaries - 2 papers

Hi Wayne and Jay, is it possible to provide a plain language overview of the findings of the 2 papers by cob tomorrow. Also, are we planning any further work in this area. Thanks, Arran.

**Pages 1661 to / à 1662
are withheld pursuant to sections
sont retenues en vertu des articles**

14(a), 21(1)(b), 21(1)(a)

**of the Access to Information Act
de la Loi sur l'accès à l'information**

Jaundice in Chinook Salmon on the West Coast of British Columbia

A Jaundice Syndrome occurs sporadically among sea-pen-farmed Chinook Salmon grown on the west coast of Vancouver Island, British Columbia. Affected salmon are easily identified by a distinctive yellow discolouration of their skin around their abdomen and eyes. This syndrome can result in mortalities to the fish, generally in the fall-winter periods. Little is known about the cause, incidence or distribution of this disease, including whether it is infectious or non-infectious.

In 2011, a collaborative project, funded through the DFO Aquaculture Collaborative Research and Development Program (ACRDP) was initiated among Creative Salmon Ltd, DFO (Pacific Biological Station) and other research partners. The study was design to gain a better understanding of the factors that might be causing jaundice in the Chinook Salmon; whether they are related to the environmental conditions or an infectious agent. A fish health diagnostic approach (including histopathology) and a genomics approach were used to investigate the cause(s).

The project was completed in 2012 and a draft report was produced¹, but not finalised as there was and still is a fundamental disagreement among the researchers involved on the project regarding the final conclusions of the study. While the study did find that environmental factors are implicated in the level and occurrence of jaundice in the fish due to lower salinity conditions, part of the research team contends that there is a direct and conclusive link between jaundice in Chinook Salmon and a virus (Piscine Reovirus - PRV), while other researchers that were part of the team contend that while there may be a possible link to PRV, based on the findings of this study there is not a conclusive connection to PRV and that it is not the only factor involved in causing the disease.

¹ ACRDP project draft manuscript: Histopathology and genomic characterization of idiopathic jaundice and anemia syndrome in cultured Chinook salmon (*Oncorhynchus tshawytscha*) by Kristina M. Miller, Karia H. Kaukinen, Shaorong Li, Angela Schulze, [REDACTED] Gary D. Marty, and [REDACTED]

Molecular indices of viral disease development in wild migrating salmon

In 2017, researchers at the DFO Pacific Biological Station published a study on molecular indices of viral disease in salmon (Molecular indices of viral disease development in wild migrating salmon by Kristina M. Miller, Oliver P. Günther, Shaorong Li, Karia H. Kaukinen and Tobi J. Ming in Conservation Physiology (2017) vol. 5(1): cox036; doi:10.1093/conphys/cox036). This study examined a series of molecular biomarkers

(measureable biological molecules that are characteristic for a specific physiological status) to determine the disease state of a fish. This new genomics-based approach offers a new and different, more sensitive approach compared to traditional fish health diagnostic approaches to determining the disease state of a fish. The technique has the potential to be able to determine if a fish is in an active infectious state even before a disease state may be reached, which can be a particular challenge to assess in wild fish stocks.

This study developed and validated salmon host biomarkers capable of distinguishing fish in an active viral disease state from those carrying a latent viral infection, and viral versus bacterial disease states. Biomarker discovery was conducted through a complex statistical analysis of published and in-house genomic data, and validation performed on independent datasets including disease challenge studies and farmed salmon diagnosed with various viral, bacterial and parasitic diseases. One of these datasets included the analysis of fish and findings from the ACRDP study on jaundice in farmed Chinook Salmon (see above). The specific finding associated with jaundice included the identification of some biomarkers that were able to distinguish between healthy and diseased Chinook, as well as noting a correlation with PRV.

Other Research

Other research on jaundice has been recently undertaken by research at the DFO Pacific Biological Station and includes a study examining jaundice and PRV on salmon (Piscine reovirus, but not Jaundice Syndrome, was transmissible to Chinook Salmon, *Oncorhynchus tshawytscha* (Walbaum), Sockeye Salmon, *Oncorhynchus nerka* (Walbaum), and Atlantic Salmon, *Salmo salar* L. by K A Garver, G D Marty, S N Cockburn, J Richard, L M Hawley, A Muller, R L Thompson, M K Purcell and S Saksida in the Journal of Fish Diseases (2015) doi:10.1111/jfd.12329.

The results from this study demonstrate that the Jaundice Syndrome was not transmissible by injection of material from infected fish and that PRV was not the sole causative factor for the condition. Additionally, these findings showed the Pacific coast strain of PRV, while transmissible, was of low pathogenicity for Atlantic Salmon, Chinook Salmon and Sockeye Salmon.

Miller-Saunders, Kristi

From: Miller-Saunders, Kristi
Sent: November-26-17 7:37 PM
To: Brian Riddell
Subject: FW: Summary information needed for PRv-HSMI Workshop
Attachments: PRV-HSMI-current information-DRAFT.pptx

FYI

From: Marty, Gary D AGRI:EX [Gary.Marty@gov.bc.ca]
Sent: November 26, 2017 1:21 PM
To: 'Maureen Purcell (mpurcell@usgs.gov)'; Miller-Saunders, Kristi; 'Kathleen Frisch'; Garver, Kyle; Johnson, Stewart; Gagne, Nellie; 'Tony Farrell (tony.farrell@ubc.ca)'; DiCicco, Emiliano; Polinski, Mark; 'Espen Rimstad (espen.rimstad@nmbu.no)'; [REDACTED] 'George Iwama
Cc: [REDACTED]
Subject: Summary information needed for PRv-HSMI Workshop

Workshop Title: **Exploring PRv & HSMI in Europe & BC**

Dear Presenters,

I am looking forward to hearing your presentation at the workshop.

For the final session of the workshop (Tuesday afternoon), "**Regional comparisons & next steps: Are we on the same page & where do we go from here? – Structured Speaker Panel Discussion**", I seek your assistance:

1. I am preparing to introduce the session with a brief summary of PRV and HSMI in Europe and BC (draft attached). Some of my draft entries might be incorrect or incomplete.
REQUEST - Please send me any additions, corrections, or other suggestions for the attached file.
2. I am also planning to present a summary of the most important information from each presentation. [I want to be sure to include information from talks that do not directly address PRV or HSMI in Europe or BC (but still provide important perspective).]
REQUEST - Please send me one to three bullets that summarize the "take home" message(s) from your presentation.

I will be able to integrate written notes into my summary if I receive them before 10pm Monday evening. Otherwise, I will do my best to integrate what I hear from you directly or during your talk (I will be taking notes during the sessions).

Best regards,

Gary

Gary D. Marty, Senior Fish Pathologist
Animal Health Centre
Ministry of Agriculture
1767 Angus Campbell Rd.
Abbotsford, BC, V3G 2M3
604-556-3123

s.19(1)

PRV – current information

	Norway	BC
First Detection	(Palacios et al. 2010)	Sept. 13, 2010 (BC Animal Health Centre, unpublished) 2012 (Kibenge et al. 2013)
Earliest detection	?	1987 – several PCR+ results in wild and farm salmon (Marty et al. 2015)
Marine farm salmon prevalence	Most salmon farms are PCR+	The majority of farm salmon are PCR+ after 4 - 6 months at sea
Marine wild salmon prevalence	13% (Atlantic salmon, Garseth et al. 2014)	0 – 20% (Miller et al. 2014; Marty et al. 2015)
Causes subclinical HSMI?	Yes (Wessel et al. 2017)	No (Garver et al. 2016a)
Affects stress test performance?	?	To be presented(?) (Farrell et al. unpublished)
Causes clinical HSMI?	No (Wessel et al. 2017)	No (Garver et al. 2016b)
Occurs with HSMI?	Yes (Palacios et al. 2010)	Yes (Di Cicco et al. 2017)

HSMI – current information

	Norway	BC
Earliest report of idiopathic cardiomyopathy	?	November 1990 (Brackett et al. 1991)
First public report of consistent heart and skeletal muscle inflammation	1999 (reported in Kongtorp et al. 2004)	2013 (GD Marty. 2013; Canadian Federal Court affidavit) 2017 (Di Cicco et al. 2017. PLoS ONE)
Estimated mortality on affected farm(s)	0 – 20% (Kongtorp et al. 2004)	~0.2% (source: Di Cicco et al. 2017. PLoS ONE)
Marine wild salmon prevalence	0% (n = 21 PRV+ fish; Garseth et al. 2014)	0% (n = 204; Marty et al. 2015)
Subclinical disease transmissible?	Yes (Kongtorp et al. 2004)	To be presented(?) (Polinski et al., unpublished)
Clinical disease transmissible?	No (Kongtorp et al. 2004)	No (Garver et al. 2016b)

Literature Cited

- Brackett, J., G. Newbound, and D. Speare. 1991. A fall survey of saltwater morbidity and mortality in farmed salmon in British Columbia. British Columbia Ministry of Agriculture and Fisheries.
- Di Cicco, E., H.W. Ferguson, A.D. Schulze, K.H. Kaukinen, S. Li, R. Vanderstichel, O. Wessel, E. Rimstad, I.A. Gardner, K.L. Hammell, and K.M. Miller. 2017. Heart and skeletal muscle inflammation (HSMI) disease diagnosed on a British Columbia salmon farm through a longitudinal farm study. *Plos One* 12(2)
- Garseth, A.H., C. Fritsvold, M. Opheim, E. Skjerve, and E. Biering. 2013. Piscine reovirus (PRV) in wild Atlantic salmon, *Salmo salar* L., and sea-trout, *Salmo trutta* L., in Norway. *J. Fish Dis.* 36(5):483-493.
- Garver, K.A., S.C. Johnson, M.P. Polinski, J.C. Bradshaw, G.D. Marty, H.N. Snyman, D.B. Morrison, and J. Richard. 2016a. Piscine orthoreovirus from western North America is transmissible to Atlantic salmon and sockeye salmon but fails to cause heart and skeletal muscle inflammation. *Plos One* 11(1)
- Garver, K.A., G.D. Marty, S.N. Cockburn, J. Richard, L.M. Hawley, A. Muller, R.L. Thompson, M.K. Purcell, and S. Saksida. 2016b. Piscine reovirus, but not jaundice syndrome, was transmissible to Chinook Salmon, *Oncorhynchus tshawytscha* (Walbaum), sockeye salmon, *Oncorhynchus nerka* (Walbaum), and Atlantic Salmon, *Salmo salar* L. *J. Fish Dis.* 39(2):117-128.
- Kibenge, M.J.T., T. Iwamoto, Y. Wang, A. Morton, M.G. Godoy, and F.S.B. Kibenge. 2013. Whole-genome analysis of piscine reovirus (PRV) shows PRV represents a new genus in family Reoviridae and its genome segment S1 sequences group it into two separate sub-genotypes. *Virology* 50(1):10-20.
- Kongtorp, R.T., T. Taksdal, and A. Lyngoy. 2004. Pathology of heart and skeletal muscle inflammation (HSMI) in farmed Atlantic salmon *Salmo salar*. *Dis. Aquat. Org.* 59(3):217-224.

Literature Cited

- Marty, G.D. 2013. Affidavit of Dr. Gary D. Marty sworn October 30, 2013, in *Morton v. Minister of Fisheries and Oceans et al*, Canadian Federal Court No. T-789-13.
- Marty, G.D., D.B. Morrison, J. Bidulka, T. Joseph, and A. Siah. 2015. Piscine reovirus in wild and farmed salmonids in British Columbia, Canada: 1974-2013. *J. Fish Dis.* 38(8):713-728.
- Miller, K.M., A. Teffer, S. Tucker, S.R. Li, A.D. Schulze, M. Trudel, F. Juanes, A. Tabata, K.H. Kaukinen, N.G. Ginther, T.J. Ming, S.J. Cooke, J.M. Hipfner, D.A. Patterson, and S.G. Hinch. 2014. Infectious disease, shifting climates, and opportunistic predators: cumulative factors potentially impacting wild salmon declines. *Evol. Appl.* 7(7):812-855.
- Palacios, G., M. Lovoll, T. Tengs, M. Hornig, S. Hutchison, J. Hui, R.T. Kongtorp, N. Savji, A.V. Bussetti, A. Solovyov, A.B. Kristoffersen, C. Celone, C. Street, V. Trifonov, D.L. Hirschberg, R. Rabadan, M. Egholm, E. Rimstad, and W.I. Lipkin. 2010. Heart and skeletal muscle inflammation of farmed salmon is associated with infection with a novel reovirus. *Plos One* 5(7)

Miller-Saunders, Kristi

From: Brian Riddell <briddell@PSF.CA>
Sent: November-26-17 9:24 PM
To: Miller-Saunders, Kristi
Subject: Re: Summary information needed for PRv-HSMI Workshop

Thanks, not sure my week will be much better! Glad you and Emiliano are going, thanks.

[REDACTED]

On Nov 26, 2017, at 9:16 PM, Miller-Saunders, Kristi <Kristi.Saunders@dfo-mpo.gc.ca<<mailto:Kristi.Saunders@dfo-mpo.gc.ca>>> wrote:

[REDACTED]

Not particularly looking forward to this meeting, but Emiliano has done a fantastic job on the in situ's. I will forward you a link to our talk on dropbox in the morning.

Kristi

From: Brian Riddell [briddell@PSF.CA<<mailto:briddell@PSF.CA>>]
Sent: November 26, 2017 8:54 PM
To: Miller-Saunders, Kristi
Subject: Re: Summary information needed for PRv-HSMI Workshop

[REDACTED]

[REDACTED]

On Nov 26, 2017, at 7:36 PM, Miller-Saunders, Kristi <Kristi.Saunders@dfo-mpo.gc.ca<<mailto:Kristi.Saunders@dfo-mpo.gc.ca>>> wrote:

FYI

From: Marty, Gary D AGRI:EX [Gary.Marty@gov.bc.ca<<mailto:Gary.Marty@gov.bc.ca>><<mailto:Gary.Marty@gov.bc.ca>>]
Sent: November 26, 2017 1:21 PM
To: 'Maureen Purcell' (mpurcell@usgs.gov<<mailto:mpurcell@usgs.gov>><<mailto:mpurcell@usgs.gov>>'); Miller-Saunders, Kristi; 'Kathleen Frisch'; Garver, Kyle; Johnson, Stewart; Gagne, Nellie; 'Tony Farrell' (tony.farrell@ubc.ca<<mailto:tony.farrell@ubc.ca>><<mailto:tony.farrell@ubc.ca>>'); DiCicco, Emiliano; Polinski, Mark; 'Espen Rimstad' (espen.rimstad@nmbu.no<<mailto:espen.rimstad@nmbu.no>><<mailto:espen.rimstad@nmbu.no>>');

[REDACTED]

[REDACTED] 'George Iwama' ([REDACTED])

[REDACTED]

s.19(1)

1 s.21(1)(a)

s.21(1)(b)

001670

Cc: [REDACTED]

Subject: Summary information needed for PRv-HSMI Workshop

Workshop Title: Exploring PRv & HSMI in Europe & BC

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REQUEST - Please send me any additions, corrections, or other suggestions for the attached file.

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I will be able to integrate written notes into my summary if I receive them before 10pm Monday evening. Otherwise, I will do my best to integrate what I hear from you directly or during your talk (I will be taking notes during the sessions).

Best regards,

Gary

Gary D. Marty, Senior Fish Pathologist
Animal Health Centre
Ministry of Agriculture
1767 Angus Campbell Rd.
Abbotsford, BC, V3G 2M3
604-556-3123

<PRV-HSMI-current information-DRAFT.pptx>

s.19(1)

Miller-Saunders, Kristi

From: Miller-Saunders, Kristi
Sent: November-30-17 9:04 AM
To: Jones, Simon; Garver, Kyle; Higgins, Mark
Cc: Taylor, Nathan
Subject: RE: feedback needed today

I have a call till 10:30, but I will feed into this response.
Kristi

From: Jones, Simon
Sent: November-30-17 8:55 AM
To: Miller-Saunders, Kristi; Garver, Kyle; Higgins, Mark
Cc: Taylor, Nathan
Subject: RE: feedback needed today

All,

To coordinate this request into a single response, please send me your thoughts as bullet points by 11:00.

Thanks,

Simon

Simon R.M. Jones
Acting Division Manager, ADGT

*Aquatic Animal Health Section
Pacific Biological Station
Fisheries and Oceans Canada
3190 Hammond Bay Road
Nanaimo, British Columbia
V9T 6N7, Canada*

Tel: 250 729 8351
Fax: 250 756 7053
E-mail: simon.jones@dfo-mpo.gc.ca

From: Lowe, Carmel
Sent: November-30-17 8:48 AM
To: Miller-Saunders, Kristi; Garver, Kyle; Jones, Simon
Cc: Taylor, Nathan
Subject: feedback needed today

All - can you send me a short summary of the key outcomes/developments/new science of relevance to DFO coming out of the PRV-HSMI workshop this morning?

Carmel

Sent from my BlackBerry 10 smartphone on the Rogers network.

No information has been removed or severed from this page

Miller-Saunders, Kristi

From: Miller-Saunders, Kristi
Sent: November-30-17 11:04 AM
To: Taylor, Nathan
Subject: FW: BCSFA PRV-HSMI Meeting key points_Nov 30 2017_KM.docx
Attachments: BCSFA PRV-HSMI Meeting key points_Nov 30 2017_KM.docx

I meant to CC you on this. Carmel has asked for a summary of key findings from the meeting. As Simon is acting for you, he is compiling.
Kristi

From: Miller-Saunders, Kristi
Sent: November-30-17 11:03 AM
To: Jones, Simon; Garver, Kyle (Kyle.Garver@dfo-mpo.gc.ca); Higgins, Mark
Subject: BCSFA PRV-HSMI Meeting key points_Nov 30 2017_KM.docx

Key take-home points from the PRV/HSMI meeting held by the BCSFA

- PRV causation of HSMI is not controversial in Norway.
- In Norway, despite the fact that most farmed fish become positive for PRV in the marine environment, they find that infection of hatchery smolts in freshwater is a risk factor towards the development of more impactful outbreaks of HSMI. In recent years, HSMI outbreaks have occurred as well in freshwater, which tend to cause higher rates of mortality (up to 50%) than typical marine outbreaks (0-5% on average).
- There is evidence around the world that various strains of PRV have also been associated with diseases in *Oncorhynchus* species, principally Coho salmon in Chile and Japan, Rainbow trout in Norway, Chile and Washington State, and Chinook salmon in BC. In Washington and BC, diseases are associated with the same strain of PRV (PRV-1a) that is causative of HSMI.
- In Norway, HSMI was first observed in 1999, but shifted over two decades from a disease impacting only dozens of farms in central Norway to one that has spread throughout the entire Norwegian coast, impacting 100's of farms every year. Their scientists felt that they waited too long (5 years) to act on properly reporting and tracking this disease, and advised that even if HSMI is not presently highly economically impactful in BC, that action to track and limit its spread should be taken sooner rather than later.
- The Norwegian scientists believe that PRV/HSMI may be underestimated and may also contribute to co-infection pathologies but not specifically recognized as the cause of death.
- Preliminary vaccine trials have indicated that vaccines can reduce the development of HSMI, but have not yet resulted in complete protection.
- The three main risk factors toward PRV infection resulting in development of HSMI in Norway are: 1) previous outbreak on same farm, 2) PRV positive smolts put onto farms, 3) nearby farm outbreak—can spread large distances, 4) transmission through feces.
- In situ hybridization studies by BC scientists have shown that the PRV-1a strain in BC is tightly linked with the development of HSMI in Atlantic salmon and Jaundice/anemia in farmed Chinook salmon, whereby the virus is spatially localized within the tissue regions and cells that are damaged by each disease.

Miller-Saunders, Kristi

From: Miller-Saunders, Kristi
Sent: November-30-17 11:14 AM
To: Jones, Simon; Garver, Kyle (Kyle.Garver@dfo-mpo.gc.ca); Higgins, Mark
Cc: Taylor, Nathan
Subject: RE: BCSFA PRV-HSMI Meeting key points_Nov 30 2017_KM.docx

I should have added one more bullet:

Mitigation measures being pursued in Norway include: 1) PRV-free smolts, which involves either screening broodfish and use of only low PRV load carriers or use of on land broodstock with no exposure to PRV, 2) Reduce stress and handling, 3) use of functional diets—highly plant-based diets increase inflammatory responses, hence at an early phase of HSMI development, they switch fish to diets higher in fish-oil.

Kristi

From: Miller-Saunders, Kristi
Sent: November-30-17 11:03 AM
To: Jones, Simon; Garver, Kyle (Kyle.Garver@dfo-mpo.gc.ca); Higgins, Mark
Subject: BCSFA PRV-HSMI Meeting key points_Nov 30 2017_KM.docx

Miller-Saunders, Kristi

From: Miller-Saunders, Kristi
Sent: November-30-17 12:02 PM
To: Brian Riddell
Cc: DiCicco, Emiliano
Subject: BCSFA PRV workshop feedback from DFO Scientists_Nov 30 2011.docx
Attachments: BCSFA PRV workshop feedback from DFO Scientists_Nov 30 2011.docx

I thought you might enjoy reading the variances in what individuals got out of the PRV-HSMI workshop. Quite telling actually. [REDACTED]

Kristi

s.21(1)(a)

s.21(1)(b)

PRV/HSMI Workshop Feedback

OVERVIEW

- Information presented at the Workshop emphasised the different relationship between PRV and HSMI that occurs in BC and Norway.
- Evidence for a causal link between PRV and HSMI is weak in BC and strong in Norway
- Several hypotheses focusing on host, virus and/or environmental variables were presented to explain the differences between the Norwegian and BC experiences.
- The relevance to DFO is twofold: 1, potential impacts to wild salmon and 2, occurrence of HSMI-like diseases in farmed Atlantic salmon in BC.
- Research is presently underway to test these hypotheses and to address the knowledge gaps
- detailed observations from DFO attendees are listed below

MILLER

- PRV causation of HSMI is not controversial in Norway.
- In Norway, despite the fact that most farmed fish become positive for PRV in the marine environment, they find that infection of hatchery smolts in freshwater is a risk factor towards the development of more impactful outbreaks of HSMI. In recent years, HSMI outbreaks have occurred as well in freshwater, which tend to cause higher rates of mortality (up to 50%) than typical marine outbreaks (0-5% on average).
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Chinook salmon, whereby the virus is spatially localized within the tissue regions and cells that are damaged by each disease.

- Mitigation measures being pursued in Norway include: 1) PRV-free smolts, which involves either screening broodfish and use of only low PRV load carriers or use of on land broodstock with no exposure to PRV, 2) Reduce stress and handling, 3) use of functional diets—highly plant-based diets increase inflammatory responses, hence at an early phase of HSMI development, they switch fish to diets higher in fish-oil.

MACWILLIAMS

- In Norway this appears to be a self limiting infection, except for the subpopulation of individuals that experience a type IV hypersensitivity reaction with progression to a disease state with low cumulative mortality
- Norwegian disease outbreak experience typically involves concurrent infections or recent infections (resulting in a sensitized/reactive immune system?)
- Canadian situation - self limiting infection, typically asymptomatic, little-to-no apparent clinical relevance from a herd health perspective
- Transmission from an unknown wild marine reservoir, highly contagious (easily spread) within a farm population, with 100% prevalence for infection within 6 months of initial detection
- Lower prevalence in wild Pacific salmon could be due to host response (i.e. species-specific differences in number or types of cellular receptors for viral attachment to erythrocytes) or related to poor viral particle survival outside a host
- Adopting a standard case definition, encompassing both farm level clinical presentation and pathology, would add clarity to future discussions and communications

GARVER

- Kathleen Frisch, [REDACTED] and Espen Rimstad presented on the occurrence of HSMI in Norway. In Norway, the disease HSMI is associated with clinical signs of disease on the farm and is a production concern. However the disease often co-occurs with other diseases or is present with mixed aetiologies, such as CMS, PD which have not been found to be present in BC or USA waters. HSMI rarely occurs as the sole disease in Norwegian aquaculture.
- Lesions characteristic for HSMI have been recreated in Norwegian laboratory studies when fish are exposed to purified PRV indicating that PRV is the cause of HSMI. However the clinical disease as it occurs in Norwegian Aquaculture has not been recreated in a laboratory setting. This suggests that there are environmental or other disease determinate factors that are required to get clinical disease. Research is ongoing in Norway, Canada, and the USA to better understand the factors required to cause HSMI.
- In Norway, HSMI resistant Atlantic salmon have been developed by AquaGen. Fish appear to be less susceptible to the disease however they appear to be equally susceptible to PRV infection, pointing towards the importance of host factors in the development of HSMI disease.

- Moreover, research presented by Drs Mark Polinski and Emiliano DiCicco point towards a plausible hypothesis that HSMI may be a result of a hypersensitivity type reaction whereby host macrophages are activated causing an inflammatory response.
- To date, laboratory studies in Canada have demonstrated that despite high PRV loads in a salmon host, HSMI has not been induced. Minor inflammation has been observed due to the presence of PRV however these lesions have not resulted in any measurable harm to the respiratory physiology of Atlantic salmon.
- PRV is present on the east coast of Canada and is highly prevalence in Atlantic salmon aquaculture where typically prevalence reaches 100% by 6 months post seawater entry. The viral source for these infections remains unknown.
- All Pacific salmonid appear susceptible to PRV infection, however surveillance of wild/free ranging stocks suggest Coho and Chinook salmon to be the most susceptible. In farmed Chinook in BC, PRV has been associated with a jaundice syndrome and in Washington state, PRV has been associated with erythrocytic inclusion body syndrome (EIBS) in hatchery reared coho salmon. What role PRV plays in these syndromes remains unknown. Research studies are being conducted in the USA to better understand the relationship of PRV and EIBS.
- Collaborative studies are also underway between Norway and Canada that involves side-by-side comparisons of the Norwegian –PRV vs. British Columbia-PRV in their ability to cause disease in Atlantic salmon. This direct comparison of viruses within one laboratory will allow for an evaluation of host, environment and virus factors to be individually measured with the ultimate goal of determining the factors responsible for disease development.

HIGGINS

- The PRV/HSMI experience in Norway is very different than that seen in BC. It was clear from presentations given by the Norwegian Researchers that there are multiple disease issues on Norwegian farms that lead to a much higher level of mortality among farms over the course of a production cycle. This is not the case in BC.
- Mitigation strategies in Norway include 1) avoiding stressful situations on farms where HSMI has been detected (i.e. lice treatments) 2) use of PRV negative (screened) eggs if possible (the Norwegians do not remove PRV+ eggs from production), and 3) use of functional diets (higher in fish oils).
- Mortality is most common now in the 1-5% range for HSMI outbreaks (no longer do they see 20%). However, freshwater outbreaks of HSMI have seen mortality as high as 50%
- In Norway, the presence of PRV in fish tends to reduce the incidence of Salmon Alpha Virus (SAV) which can cause much higher mortality and is considered as a reportable disease.
- While HSMI has been reported in BC, the overall impact to farmed Atlantic salmon is minimal.

Dickie, Catherine

From: Lowe, Carmel
Sent: November 30, 2017 12:25 PM
To: Jones, Simon
Cc: Taylor, Nathan; Miller-Saunders, Kristi; Garver, Kyle; Higgins, Mark; MacWilliams, Christine
Subject: RE: feedback needed today

Follow Up Flag: Follow up
Flag Status: Completed

Thanks all – really appreciate your summaries. Lots of fodder in these reports for us to consider as we move forward with our aquaculture research programs

Carmel

Carmel Lowe, Ph.D.
Regional Director Science | Directrice régionale des sciences
Fisheries and Oceans Canada | Pêches et Océans Canada
Pacific Biological Station | Station biologique du Pacifique
3190 Hammond Bay Rd, Nanaimo, BC, Canada V9T 6N7

Carmel.Lowe@dfo-mpo.gc.ca
Telephone | Téléphone 250-756-7177
Facsimile | Télécopieur 250-729-8360
Government of Canada | Gouvernement du Canada

From: Jones, Simon
Sent: Thursday, November 30, 2017 11:53 AM
To: Lowe, Carmel <Carmel.Lowe@dfo-mpo.gc.ca>
Cc: Taylor, Nathan <Nathan.Taylor@dfo-mpo.gc.ca>; Miller-Saunders, Kristi <Kristi.Saunders@dfo-mpo.gc.ca>; Garver, Kyle <Kyle.Garver@dfo-mpo.gc.ca>; Higgins, Mark <Mark.Higgins@dfo-mpo.gc.ca>; MacWilliams, Christine <Christine.MacWilliams@dfo-mpo.gc.ca>
Subject: RE: feedback needed today

Carmel,

As requested, an overview of the PRV/HSMI workshop.

Simon

Simon R.M. Jones
Acting Division Manager, ADGT

*Aquatic Animal Health Section
Pacific Biological Station
Fisheries and Oceans Canada
3190 Hammond Bay Road*

Nanaimo, British Columbia
V9T 6N7, Canada

Tel: 250 729 8351

Fax: 250 756 7053

E-mail: simon.jones@dfo-mpo.gc.ca

From: Lowe, Carmel

Sent: November-30-17 8:48 AM

To: Miller-Saunders, Kristi; Garver, Kyle; Jones, Simon

Cc: Taylor, Nathan

Subject: feedback needed today

All - can you send me a short summary of the key outcomes/developments/new science of relevance to DFO coming out of the PRV-HSMI workshop this morning?

Carmel

Sent from my BlackBerry 10 smartphone on the Rogers network.

Ryan, Patricia

From: Moore, Wayne
Sent: November-30-17 12:24 PM
To: Thomson, Andrew
Cc: McPherson, Arran; Parsons, Jay; Lowe, Carmel; LaRue, Jean-François
Subject: Pathogen transfer risk assessment
Attachments: Temp1.xlsx; temp2.xlsx

Andy,

Great chat yesterday.

Attached are the documents we mentioned.

I know Jay was out recently speaking to Corey and Nathan (from Carmel's shop) on this amongst other things. As discussed, I think it would be a great idea for the four of us (you, me, Carmel and J-F) to get collectively briefed on this soon so that we can ensure that the needed resources et al are aligned and that if we see any problems down the road we can flag them now.

Happy to organize if you would find that of value.

W

Wayne Moore

*Director General, Strategic and Regulatory Science
Fisheries and Oceans Canada / Government of Canada
Wayne.Moore@dfo-mpo.gc.ca / Tel: 613-990-0001*

*Directeur général, Sciences stratégiques et réglementaires
Pêches et Océans Canada / Gouvernement du Canada
Wayne.Moore@dfo-mpo.gc.ca / Tél. : 613-990-0001*

Web: [DFO/MPO](#)

Twitter: [DFO/MPO/DFO-Science/MPO-Science](#)

s.19(1)

Systemic bacterial infection risk assessments

To be completed by: Pathogen transfer risk assessment team

Deadline: Jul-18

Bacterial Kidney Disease (BKD)

% done	Phase	Due By	Notes (lead)
25%	Problem formulation	8-Dec-17	Caroline Mimeault
0%	Pathogen characterisation	12-Jan-18	Linda Rhodes (NOAA)
0%	Risk assessment	27-Apr-18	Caroline Mimeault
0%	Science Advisory Report	6-Jul-18	Ingrid Burgetz and Jay Parsons

Enteric Redmouth Disease (ERM)

% done	Phase	Due By	Notes
25%	Problem formulation	8-Dec-17	Caroline Mimeault
0%	Pathogen characterisation	12-Jan-18	Joy Wade (AquaFundy)
0%	Risk assessment	27-Apr-18	Caroline Mimeault
0%	Science Advisory Report	6-Jul-18	Ingrid Burgetz and Jay Parsons

Furunculosis

% done	Phase	Due By	Notes
25%	Problem formulation	8-Dec-17	Caroline Mimeault
0%	Pathogen characterisation	12-Jan-18	France Boily
0%	Risk assessment	27-Apr-18	Caroline Mimeault
0%	Science Advisory Report	6-Jul-18	Ingrid Burgetz and Jay Parsons

Salmonid Rickettsial Septicaemia (SRS)

% done	Phase	Due By	Notes
25%	Problem formulation	8-Dec-17	Caroline Mimeault
0%	Pathogen characterisation	12-Jan-18	Simon Jones
0%	Risk assessment	27-Apr-18	Caroline Mimeault
0%	Science Advisory Report	6-Jul-18	Ingrid Burgetz and Jay Parsons

Pathogen Transfer Risk Assessments in the Discovery Islands (bacteria causing systemic infections)

Components	Step	Due By	Completed On	Lead	Bacterial Kidney Disease (BKD)	Enteric Redmouth (ERM)	Furunculosis	Salmonid rickettsial septicemia (SRS)	Notes
Problem formulation	Problem formulation (draft)	10-Nov-17	10-Nov-17	Caroline	100	100	100	100	Caroline
	Meeting with client	10-Nov-17		Jay/Ingrid	0	0	0	0	Jay/Ingrid
	Engage with CHIA	10-Nov-17		Wayne/Jay	0	0	0	0	Wayne/Jay
	Working group formation	17-Nov-17		Jay/Ingrid	0	0	0	0	Jay/Ingrid
	Working group meeting	30-Nov-17		Ingrid/Caroline	0	0	0	0	Ingrid/Caroline
Communications	Problem formulation (final)	8-Dec-17		Caroline	0	0	0	0	Caroline
	Update industry	TBD		Jay/Ingrid	0	0	0	0	Jay/Ingrid
	Debrief NGOs, First Nations, province	TBD		Jay/Ingrid	0	0	0	0	Jay/Ingrid
Data	Case definition	18-Oct-17	1-Nov-17	Ian/Caroline/France	100	100	100	100	Ian/Caroline/France
	Contact industry	20-Oct-17	2-Nov-17	Jay	100	100	100	100	Jay
	Industry data acquisition	10-Nov-17		Ingrid/Caroline	0	0	0	0	Ingrid/Caroline
Pathogen working paper	Industry data analysis	26-Jan-18		Caroline/France/epi?	0	0	0	0	Caroline/France/epi?
	Outlines	2-Oct-17	2-Oct-17	Caroline	100	100	100	100	Caroline
	Identification of lead author	2-Oct-18	2-Oct-18	Ingrid/Caroline	100	100	100	100	Ingrid/Caroline
	Pathogen working paper (draft)	12-Jan-18		Joy Wade	0	0	10	0	Simon Jones
	Distribution for peer review	4-May-18		Caroline	0	0	0	0	Caroline
Risk assessment working paper	Pathogen working paper (reviewed)			Linda Rhodes	0	0	0	0	Simon Jones
	Pathogen working paper (approval)			Linda Rhodes	0	0	0	0	Simon Jones
	Pathogen working paper (final)	1-Sep-18		Joy Wade	0	0	0	0	Simon Jones
	Risk assessment workshop	2-Feb-18		Ingrid/Caroline	0	0	0	0	Ingrid/Caroline
	Risk assessment (draft)	16-Mar-18		Caroline and WG	0	0	0	0	Caroline and WG
CSAS peer-review process	Distribution for peer review	4-May-18		Caroline	0	0	0	0	Caroline
	Risk assessment (reviewed)			Caroline and WG	0	0	0	0	Caroline and WG
	Risk assessment (approval)			Caroline and WG	0	0	0	0	Caroline and WG
	Risk assessment (final)	1-Sep-18		Caroline and WG	0	0	0	0	Caroline and WG
	Meeting agenda	4-May-18		Caroline/France	0	0	0	0	Caroline/France
Deliverables	Distribution of meeting material	4-May-18		Steering committee	0	0	0	0	Steering committee
	Presentation for pathogen paper	15-Jun-18		Linda Rhodes	0	0	0	0	Simon Jones
	Presentation for risk assessment	15-Jun-18		Caroline/France	0	0	0	0	Caroline/France
	CSAS peer-review meeting	15-Jun-18		CSAS meeting chair	0	0	0	0	CSAS meeting chair
	Reviewed pathogen paper			Linda Rhodes	0	0	0	0	Simon Jones
	Reviewed risk assessment			Caroline	0	0	0	0	Caroline
	Draft SAR			CSAS participants	0	0	0	0	CSAS participants
	Revised SAR			Caroline/France	0	0	0	0	Caroline/France
	Approval of pathogen paper			CSAS chair	0	0	0	0	CSAS chair
	Approval of risk assessment			CSAS chair	0	0	0	0	CSAS chair
	Approval of SAR			CSAS chair	0	0	0	0	CSAS chair
	Translation of SAR			CSAS office	0	0	0	0	CSAS office
	Translation of figures included in SAR			Caroline/France	0	0	0	0	Caroline/France
	Submission of pathogen paper	1-Sep-18	1-Sep-18	Jay	0	0	0	0	Jay
	Submission of risk assessment	1-Sep-18	1-Sep-18	Jay	0	0	0	0	Jay
	Submission of SAR (English)			Jay	0	0	0	0	Jay
	Submission of SAR (Francais)			Jay	0	0	0	0	Jay
				Jay	0	0	0	0	Jay

001686

ESTIMATED TIMELINES FOR PATHOGEN TRANSFER RISK ASSESSMENTS IN THE DISCOVERY ISLANDS, BC (reviewed on October 19, 2017)

Risk assessment phase	Pathogen	Disease	Sep-17	Oct-17	Nov-17	Dec-17	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20		
Virus	Viral hemorrhagic septicaemia virus	Viral hemorrhagic septicaemia (VHS)																																							
	<i>Aeromonas salmonicida</i>	Furunculosis																																							
Bacteria causing systemic infections	<i>Piscirickettsia salmonis</i>	Salmonid rickettsial septicaemia (SRS)																																							
	<i>Renibacterium salmoninarum</i>	Bacterial kidney disease (BKD)																																							
	<i>Yersinia ruckeri</i>	Enteric redmouth disease (ERM)																																							
	<i>Moritella viscosa</i>	Winter ulcers																																							
Bacteria causing erosive lesions	<i>Tenacibaculum maritimum</i>	Mouth rot																																							
	<i>Paramoeba perurans</i>	Amoebic gill disease																																							
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Ryan, Patricia

From: Moore, Wayne
Sent: November-30-17 3:57 PM
To: Lowe, Carmel; McPherson, Arran; Taylor, Nathan; Parsons, Jay
Subject: RE: Request for feedback

Fabulous. Thanks.

From: Lowe, Carmel
Sent: November 30, 2017 3:26 PM
To: McPherson, Arran <Arran.McPherson@dfo-mpo.gc.ca>; Moore, Wayne <Wayne.Moore@dfo-mpo.gc.ca>; Taylor, Nathan <Nathan.Taylor@dfo-mpo.gc.ca>; Parsons, Jay <Jay.Parsons@dfo-mpo.gc.ca>
Subject: Request for feedback

fyi

Carmel

Carmel Lowe, Ph.D.
Regional Director Science | Directrice régionale des sciences
Fisheries and Oceans Canada | Pêches et Océans Canada
Pacific Biological Station | Station biologique du Pacifique
3190 Hammond Bay Rd, Nanaimo, BC, Canada V9T 6N7

Carmel.Lowe@dfo-mpo.gc.ca
Telephone | Téléphone 250-756-7177
Facsimile | Télécopieur 250-729-8360
Government of Canada | Gouvernement du Canada

From: Jones, Simon
Sent: Thursday, November 30, 2017 11:53 AM
To: Lowe, Carmel <Carmel.Lowe@dfo-mpo.gc.ca>
Cc: Taylor, Nathan <Nathan.Taylor@dfo-mpo.gc.ca>; Miller-Saunders, Kristi <Kristi.Saunders@dfo-mpo.gc.ca>; Garver, Kyle <Kyle.Garver@dfo-mpo.gc.ca>; Higgins, Mark <Mark.Higgins@dfo-mpo.gc.ca>; MacWilliams, Christine <Christine.MacWilliams@dfo-mpo.gc.ca>
Subject: RE: Request for feedback

Carmel,

As requested, an overview of the PRV/HSMI workshop.

Simon

Simon R.M. Jones
Acting Division Manager, ADGT

*Aquatic Animal Health Section
Pacific Biological Station
Fisheries and Oceans Canada
3190 Hammond Bay Road
Nanaimo, British Columbia
V9T 6N7, Canada*

Tel: 250 729 8351

Fax: 250 756 7053

E-mail: simon.jones@dfo-mpo.gc.ca

From: Lowe, Carmel

Sent: November-30-17 8:48 AM

To: Miller-Saunders, Kristi; Garver, Kyle; Jones, Simon

Cc: Taylor, Nathan

Subject: Request for feedback

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Carmel

Sent from my BlackBerry 10 smartphone on the Rogers network.

**Pages 1690 to / à 1691
are withheld pursuant to sections
sont retenues en vertu des articles**

14(a), 21(1)(b), 21(1)(a)

**of the Access to Information Act
de la Loi sur l'accès à l'information**

McLeod, Patricia

From: Miller-Saunders, Kristi
Sent: December 5, 2017 4:10 PM
To: Taylor, Nathan
Subject: RE: [REDACTED]

[REDACTED]

From: Taylor, Nathan
Sent: December 5, 2017 3:54 PM
To: Miller-Saunders, Kristi
Subject: [REDACTED]

Hi Kristi,

[REDACTED]

Thanks!

Nathan

Nathan G. Taylor, Ph.D.
Division Manager | Directeur de secteur
Aquatic Diagnostics Genomics and Technology Division | Division des diagnostics, la genomique, de la technologie
aquatique Fisheries and Oceans Canada | Peches et Oceans Canada Pacific Biological Station | Station biologique du
Pacifique
250-756-7395

s.21(1)(a)

s.21(1)(b)

s.23

Parsons, Jay

From: Taylor, Nathan
Sent: Tuesday, December 05, 2017 7:05 PM
To: Marty, Gary D AGRI:EX
Cc: [REDACTED] - Creative Salmon'; [REDACTED] - Creative Salmon';
Parsons, Jay
Subject: [REDACTED]

Thanks for this.

[REDACTED]

I'll be back in touch regarding what is said when I have news.

Best

Nathan

s.14(a)

s.21(1)(a)

s.21(1)(b)

s.23

Page 1694

**is withheld pursuant to sections
est retenue en vertu des articles**

14(a), 21(1)(b), 23, 21(1)(a)

**of the Access to Information Act
de la Loi sur l'accès à l'information**

Miller-Saunders, Kristi

From: Miller-Saunders, Kristi
Sent: December-06-17 9:19 AM
To: pac.prmc / pac.urpcm (DFO/MPO)
Subject: RE: ** INPUT NEEDED** URGENT ** : Incoming 2017-001-02372

Actually I see that you did address the monitoring program, so you can leave it as is. However, you may want to talk to Corey about any corrections or additions.

*** Regarding your statement about Dr. Miller-Saunders February 2017 research, the Department prides itself on maintaining an objective science research program, focused on DFO's priority issues. Results of this research are peer reviewed and published in international scientific journals. DFO scientists take into account all peer-reviewed science of which they are aware. DFO's monitoring programs evolve/are updated as research identifies new methodologies that offer improved results.

Kristi

From: pac.prmc / pac.urpcm (DFO/MPO)
Sent: December 5, 2017 6:17 PM
To: Miller-Saunders, Kristi
Subject: RE: ** INPUT NEEDED** URGENT ** : Incoming 2017-001-02372

Would you be able to edit the text so it is correct and addresses the implication, please?

-----Original Message-----

From: Miller-Saunders, Kristi
Sent: Tuesday, December 05, 2017 6:14 PM
To: pac.prmc / pac.urpcm (DFO/MPO)
Subject: RE: ** INPUT NEEDED** URGENT ** : Incoming 2017-001-02372

Yes I think that would work. However the audit program is not a research program so if you are responding to an implied criticism made in my paper on our regulatory program, which was really placed there to explain why HSMI was not diagnosed previously through this program, I am not sure that is covered in your research statement.

From: pac.prmc / pac.urpcm (DFO/MPO)
Sent: December 5, 2017 5:44 PM
To: Miller-Saunders, Kristi
Subject: RE: ** INPUT NEEDED** URGENT ** : Incoming 2017-001-02372

Hi Kristi,

In the draft, I have this paragraph:

The Department prides itself on maintaining an objective science research program, focused on DFO's priority issues. Results of this research are peer reviewed and published in international scientific journals. DFO scientists take into account all peer-reviewed science of which they are aware.

*could we say something like the text below, after the ***? I'm unsure how much we can add re HSMI, since we've been told not to add to our standard lines since they and the website offer a complete response, BUT if you feel a direct reference is appropriate, [REDACTED]

s.21(1)(a)

1

s.21(1)(b)

s.23

001695

*** Regarding your statement about Dr. Miller-Saunders February 2017 research, the Department prides itself on maintaining an objective science research program, focused on DFO's priority issues. Results of this research are peer reviewed and published in international scientific journals. DFO scientists take into account all peer-reviewed science of which they are aware. DFO's monitoring programs evolve/are updated as research identifies new methodologies that offer improved results.

Thanks
Candace.

-----Original Message-----

From: Miller-Saunders, Kristi
Sent: Tuesday, December 05, 2017 5:11 PM
To: pac.prmc / pac.urpcm (DFO/MPO)
Subject: RE: ** INPUT NEEDED** URGENT ** : Incoming 2017-001-02372

I will review what the paper said but we would have never suggested the program was "faulty" but I believe we did point out that it was not designed to recognize or track emerging disease issues but rather was designed to ensure compliance for reportable diseases. Moreover, while the program does track common easily recognized endemic diseases it does not have any built in measures to follow up on lesion patterns that do not fit those from well characterized diseases. The only aspect i suppose that may be referred to as faulty was the lack of inclusion of skeletal muscle or pancreas tissues which are required to differentiate HSMI from pancreas disease or cardiomyopathy syndrome. This was pointed out by the pathologist from tge sshi who teach the slides from 2011 to 2013. From 2013 onward these tissues were included.

Kristi

From: pac.prmc / pac.urpcm (DFO/MPO)
Sent: December 5, 2017 4:59 PM
To: Miller-Saunders, Kristi
Subject: RE: ** INPUT NEEDED** URGENT ** : Incoming 2017-001-02372

Hi,
I was just letting you know what our standard lines are on PRV (the material inside the quotation marks). That included the website link. We [REDACTED] were told the website would be updated as necessary with approved lines (I see it was last updated May 26).

I just need any input you might have re their comments (bottom of page 4) that your Feb 2017 paper criticizes "the faulty scientific approaches" used in the Fish Health and Surveillance Program.

I've drafted the response and am about to send it to AQ staff for review. I've left a placeholder for your input.
Thanks
Candace

-----Original Message-----

From: Miller-Saunders, Kristi
Sent: Tuesday, December 05, 2017 4:34 PM
To: pac.prmc / pac.urpcm (DFO/MPO)
Subject: RE: ** INPUT NEEDED** URGENT ** : Incoming 2017-001-02372

Hello Candace,

s.21(1)(a)

s.21(1)(b)

s.23

I [REDACTED] will try to take a look at this material tonight. Not sure why you are pointing me to the website as I was one of the scientists who contributed to it. It becomes out of date rapidly however as scientists continue to study this issue.

Kristi

From: pac.prmc / pac.urpcm (DFO/MPO)
Sent: December 5, 2017 3:29 PM
To: Miller-Saunders, Kristi
Subject: ** INPUT NEEDED** URGENT ** : Incoming 2017-001-02372

Hi Kristi

I'm working on a draft and will be talking to Corey about our approach. But in the meanwhile, I'm specifically looking for any input you might have re their comments (bottom of page 4) that your Feb 2017 paper criticizes "the faulty scientific approaches" used in the Fish Health and Surveillance Program.

I don't need input re PRV [REDACTED] (the website includes a reference to your 2017 study): "Regarding your comments regarding heart and skeletal muscle inflammation (HSMI) and piscine reovirus (PRV), DFO's website<<http://www.dfo-mpo.gc.ca/science/aah-saa/species-especes/aq-health-sante/prv-rp-eng.html>> has detailed and up-to-date information. I strongly encourage you to read this material, which provides the scientific and historical context of this complex issue."

I need your input asap : [REDACTED]

Thanks
Candace

s.19(1)
s.21(1)(a)
s.21(1)(b)
s.23

Miller-Saunders, Kristi

From: Miller-Saunders, Kristi
Sent: December-07-17 11:12 PM
To: Thomson, Andrew
Subject: RE: recent science in the news

[REDACTED] What about the 18th?

From: Thomson, Andrew
Sent: December 7, 2017 10:22 PM
To: Miller-Saunders, Kristi
Subject: Re: recent science in the news

Hi Kristi.

I'm [REDACTED] back the following. Might be able to find a short time tomorrow

Andrew J L Thomson

Regional Director | Directeur Régionale Fisheries Management Branch | Direction de la gestion des pêches Pacific Region | Région du Pacifique Fisheries & Oceans Canada | Pêches et Océans Canada

Suite 200 – 401 Burrard St.
Vancouver, BC, Canada V6C 3S4
andrew.thomson@dfo-mpo.gc.ca
Telephone | Téléphone 604.666.0751
Facsimile | Télécopieur 250.666.8069
Government of Canada | Gouvernement du Canada.

From: Miller-Saunders, Kristi
Sent: Thursday, December 7, 2017 9:38 PM
To: Thomson, Andrew
Subject: recent science in the news

Hello Andrew,

We really should talk about our recent SSHI findings, the Creative salmon study, and the recent industry meeting. [REDACTED]
[REDACTED] Are you around next week at all?

Kristi

s.19(1)
s.21(1)(a)
s.21(1)(b)

Miller-Saunders, Kristi

From: Miller-Saunders, Kristi
Sent: December-07-17 1:14 PM
To: Tabata, Amy
Cc: Taylor, Nathan
Subject: RE: Field sampling.

Very interesting. The answer to that question is that our lab, with collaboration with Curtis marine virology lab, is the only one experienced to work with water samples. Moreover our PRV test has been diagnostocally validated with our histopathology and in situ analyses.

They came to us as the diagnostic labs said they could not process water samples.

Kristi

From: Tabata, Amy
Sent: December 7, 2017 11:03 AM
To: Miller-Saunders, Kristi
Subject: Field sampling.

Hi Kristi.

An update on the sampling this week...

I accompanied Environment Canada and BC OE personnel From Dec 4-6. We visited and inspected 2 fish processing plants in this time, and collected samples for their routine analysis as well as for viral/microbe analysis. A portion was frozen immediately (liquid nitrogen and -80), and the rest stored at 4C and further stored or processed within 72 hours.

I wanted to let you know, that the second site we visited, Lions Gate Fisheries in Tofino, is partnered with Creative Salmon. As such, [REDACTED] Creative salmon was at the second meeting with them, and was questioning why our lab was involved, and not the fish Health lab/ veterinarians. I could only say that I was there at the request of, and to assist, the 2 other organizations, and this was not a DFO-led initiative. Given the sensitivity and the huge public profile right now, [REDACTED] I talked with Nathan briefly this morning to make him aware of where I had been and what was happening. He asked for a brief description of where I had been, and with who, which I provided.

Amy

s.19(1)

s.21(1)(b)

Ryan, Patricia

From: Moore, Wayne
Sent: December-08-17 4:57 PM
To: Parsons, Jay
Subject: RE: Pathogen transfer risk assessment

This is great. I assume that it means you will be going to Vancouver for next Thursday? Or will we do it by phone. I want Caroline to be there and I want one of you or Ingrid to be here. [REDACTED]
[REDACTED] I can't afford to have both of you offsite.

From: Parsons, Jay
Sent: December 8, 2017 4:33 PM
To: Moore, Wayne <Wayne.Moore@dfo-mpo.gc.ca>
Subject: Pathogen transfer risk assessment
Importance: High

Wayne,

I want to provide an update and next steps on the pathogen Risk Assessments.

For the meeting with Carmel, JF, Andy, and yourself, we have shared the Gantt chart with the timelines for all remaining pathogens and the detailed work plan for the next four risk assessments. I have also attached a table that shows the leads for all nine risk assessments and details on the composition of the risk assessment working group team. Please let me know if additional materials are required for the meeting.

In addition, most of the key elements are in place but a couple of key gaps exist. In terms of what is in place, we have the leads for the pathogen papers and the risk assessments identified, although there are a couple of gaps for leads on some of the bacterial pathogen papers that we will need to contract externally as this expertise does not exist in the Pacific Region. As well that is great news that CFIA is onside to continue to provide risk assessment support. And we are working closely with the BCSFA to access the industry fish health data. And we continue to have the support of the Pacific Region fish health researchers and oceanographers.

But one key area we require input and expertise is around salmon population modelling expertise and approaches to support the consequence assessments for the remaining risk assessments and the overall synthesis piece.

When I was in the Pacific Region a few weeks ago discussing this and other aquaculture and genomics topics with Nathan, he brought John Holmes (Division Manager of salmon group) into the discussion on the risk assessment to start the discussion on what is needed, so that the appropriate regional experts can be identified and brought into the risk assessment team. And yesterday, I organised a call with Nathan, John and Eddy Kennedy, to make progress on identifying the salmon population and ecology experts (including ecological modelers). It quickly became apparent that in order to make progress on identifying the right staff and articulating the best modelling approach for the individual risk assessments as well as the synthesis piece that a two part face to face meeting is needed in short order to elaborate what is required from a risk assessment perspective, what salmon population modelling can offer, and what approaches and expertise can be brought to bear to support the initiative. Based on the input from Nathan, Eddy and John the only opportunity to hold this meeting is next Thursday at PBS. I have attached a draft agenda for the meeting that we are discussing with them.

As you and others have noted, this is a high priority initiatives and timelines are tight for delivering all the advice and there is significant work that needs to be completed, and we are at a critical stage that the immediate identification of experts and approaches is required for us to continue to meet the aggressive timelines that we have laid out for the next four risk assessments (as well as the remaining ones).

s.21(1)(a)

s.21(1)(b)

With regards to the next four assessment, we have a deadline of end of December/early January for receiving the draft pathogen papers (we have already received one) and these are required for us to start drafting the risk assessment papers in early January (along with the support of salmon population modelling outputs). So we are endeavouring to maintain our timelines for a June 2018 CSAS review of the next four risk assessments.

Please let me know if you have any questions or concerns with the update or approaches.

Jay

Ryan, Patricia

From: Moore, Wayne
Sent: December-11-17 8:34 AM
To: Parsons, Jay
Subject: Re: Pathogen transfer risk assessment

Thx

Sent from my BlackBerry 10 smartphone on the Rogers network.

From: Parsons, Jay
Sent: Monday, December 11, 2017 8:17 AM
To: Moore, Wayne
Subject: RE: Pathogen transfer risk assessment

The is the memo you, Carmel, Andy and JF signed-off on recently that we can share or as you say verbal briefing.

Jay

From: Moore, Wayne
Sent: Saturday, December 09, 2017 10:39 AM
To: Parsons, Jay
Subject: RE: Pathogen transfer risk assessment

Great – I think these are all the right documents. I wonder if we have on the shelf a briefing note or a deck that explains the background a bit (or alternatively I assume we can do verbally as most everyone knows). It would be good to get any assumptions we have made on the table.

From: Parsons, Jay
Sent: December 8, 2017 4:33 PM
To: Moore, Wayne <Wayne.Moore@dfo-mpo.gc.ca>
Subject: Pathogen transfer risk assessment
Importance: High

Wayne,

I want to provide an update and next steps on the pathogen Risk Assessments.

For the meeting with Carmel, JF, Andy, and yourself, we have shared the Gantt chart with the timelines for all remaining pathogens and the detailed work plan for the next four risk assessments. I have also attached a table that shows the leads for all nine risk assessments and details on the composition of the risk assessment working group team. Please let me know if additional materials are required for the meeting.

In addition, most of the key elements are in place but a couple of key gaps exist. In terms of what is in place, we have the leads for the pathogen papers and the risk assessments identified, although there are a couple of gaps for leads on some of the bacterial pathogen papers that we will need to contract externally as this expertise does not exist in the Pacific Region. As well that is great news that CFIA is onside to continue to provide risk assessment support. And we are working closely with the BCSFA to access the industry fish health data. And we continue to have the support of the Pacific Region fish health researchers and oceanographers.

But one key area we require input and expertise is around salmon population modelling expertise and approaches to support the consequence assessments for the remaining risk assessments and the overall synthesis piece.

When I was in the Pacific Region a few weeks ago discussing this and other aquaculture and genomics topics with Nathan, he brought John Holmes (Division Manager of salmon group) into the discussion on the risk assessment to start the discussion on what is needed, so that the appropriate regional experts can be identified and brought into the risk assessment team. And yesterday, I organised a call with Nathan, John and Eddy Kennedy, to make progress on identifying the salmon population and ecology experts (including ecological modelers). It quickly became apparent that in order to make progress on identifying the right staff and articulating the best modelling approach for the individual risk assessments as well as the synthesis piece that a two part face to face meeting is needed in short order to elaborate what is required from a risk assessment perspective, what salmon population modelling can offer, and what approaches and expertise can be brought to bear to support the initiative. Based on the input from Nathan, Eddy and John the only opportunity to hold this meeting is next Thursday at PBS. I have attached a draft agenda for the meeting that we are discussing with them.

As you and others have noted, this is a high priority initiatives and timelines are tight for delivering all the advice and there is significant work that needs to be completed, and we are at a critical stage that the immediate identification of experts and approaches is required for us to continue to meet the aggressive timelines that we have laid out for the next four risk assessments (as well as the remaining ones).

With regards to the next four assessment, we have a deadline of end of December/early January for receiving the draft pathogen papers (we have already received one) and these are required for us to start drafting the risk assessment papers in early January (along with the support of salmon population modelling outputs). So we are endeavouring to maintain our timelines for a June 2018 CSAS review of the next four risk assessments.

Please let me know if you have any questions or concerns with the update or approaches.

Jay

Miller-Saunders, Kristi

From: Miller-Saunders, Kristi
Sent: December-11-17 11:37 AM
To: Taylor, Nathan
Subject: FW: Fish farm update

FYI I need to respond to this ASAP. What would you like me to say?

From: Hunse, Laura A ENV:EX [<mailto:Laura.Hunse@gov.bc.ca>]
Sent: December-11-17 11:10 AM
To: Austin, Joyce ENV:EX; Miller-Saunders, Kristi
Cc: Freyman, Liz ENV:EX
Subject: RE: Fish farm update

Hi joyce, i can't answer some of those. Brady Nelless (Compliance Director) asks that questions be directed to him so we can stay on top of all info coming and out from one place. i believe he is sending out an email with this info very shortly, in the meantime, I have forwarded your email to him.

I see Amy has already responded to you with the information she does have and is directing further inquiries to Kristi Miller.

Thanks,
Laura


From: Austin, Joyce ENV:EX
Sent: Monday, December 11, 2017 10:49 AM
To: Kristi Miller (Kristi.Miller@dfo-mpo.gc.ca)
Cc: Freyman, Liz ENV:EX; Hunse, Laura A ENV:EX
Subject: FW: Fish farm update
Importance: High

Hi Kristi

I have the Minister's office asking me some questions that need answer before noon. Laura is trying to help but can you please weigh in as well?

Thank you,

Joyce Austin, Ph.D.

Senior Provincial Laboratory Specialist (Unit Head)
Environmental Monitoring, Reporting & Economics
Knowledge Management Branch | Ministry of Environment & Climate Change Strategy
Mailing address : PO Box 9347 STN PROV GOVT, Victoria, BC V8W 9M1
Physical address : 525 Superior St, Victoria, BC V8V 1T7
Tel.: 778-698-4434;
Cel.: 
Fax: 250-356-7197

From: McGuire, Jennifer ENV:EX
Sent: Monday, December 11, 2017 10:11 AM
To: Tesch, David ENV:EX; Graham, Tessa ENV:EX
Cc: Morel, David P ENV:EX
Subject: FW: Fish farm update

Need some fact checking on the highlighted bits – pls – need confirmed before noon.

- Results have come back confirming presence of PRV?? True or false? When do we expect the results?

These are EPD questions:

- If TRUE – what does that mean? What does the ministry need to do? Can the discharge be treated? How?
- What is the natural occurrence/presence of PRV in the environment?

Thanks
JLM

From: Zacharias, Mark ENV:EX
Sent: Monday, December 11, 2017 9:58 AM
To: McGuire, Jennifer ENV:EX
Subject: FW: Fish farm update

Regards, Mark

From: Zacharias, Mark ENV:EX
Sent: Monday, December 11, 2017 8:23 AM
To: Heyman, George ENV:EX
Cc: Frampton, Caelie ENV:EX; Xia, Eveline ENV:EX; Morel, David P ENV:EX; Salkus, Beverley ENV:EX
Subject: Fish farm update

Minister:

Inspections and testing:

Ministry compliance staff conducted site visits to the both the Browns Bay Packing (Campbell River) and Lions Gate Fisheries (Tofino) facilities the week of December 4, 2017. The facilities were inspected and samples were collected at both facilities. The blood they are releasing was tested and shows presence of PRV. The samples are currently undergoing lab analysis at the DFO Pacific Biological Station Lab in Nanaimo, and once the results are received, likely this week, they will be reviewed to inform next steps. The Inspection reports will be completed once we have the lab results.

Ministry staff will increase inspections at fish processing plants as part of an upcoming Audit of the sector. This includes reviewing permit requirements and making recommendations for amendments where required, as well as ensuring all regulatory requirements are met and the environment is protected. The scope and timing for the fish processing sector audit are currently being finalized and it is anticipated the results of the audit will be ready for release spring of 2018.

There are approximately 35 Fish Processing Plants (wild & farmed) in BC and there are 35 waste discharge authorizations issued under the Environmental Management Act (EMA) for fish processing plants in BC

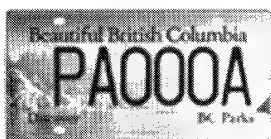
The Ministry is aware of the samples taken [REDACTED] but results have not been provided to us. Ministry compliance staff have recently taken samples as part of an inspection and are awaiting results.

Regulatory review and change:

Staff are currently identifying what steps are required to amend fish processing plant waste discharge permits under the Environmental Management Act to require the use of best available technology. Similarly, staff are reviewing the steps required to ensure best practices are mandated for sea lice treatment under the Integrated Pest Management Act.

Regards,

Mark Zacharias | Deputy Minister, Environment
BC Ministry of Environment and Climate Change Strategy
5th Floor, 2975 Jutland Road | Victoria, BC | V8W 9M1 | [REDACTED]



s.16(2)(c)

s.19(1)

Miller-Saunders, Kristi

From: Miller-Saunders, Kristi
Sent: December-11-17 12:17 PM
To: Taylor, Nathan
Subject: Release of talk I gave to Industry

The Provincial Environment agency would like me to provide a copy of the talk I gave at the PRV workshop with industry. Any reason this should be a problem?

Kristi Miller-Saunders, PhD

Head, Molecular Genetics
Pacific Biological Station
3190 Hammond Bay Rd
Nanaimo BC V9T 6N7
250-756-7155
Kristi.Saunders@dfo-mpo.gc.ca

Miller-Saunders, Kristi

From: Miller-Saunders, Kristi
Sent: December-11-17 12:53 PM
To: Taylor, Nathan
Subject: RE: bullets?

Preliminary processing to concentrate the viral RNA from the water has been done, but RNA extractions and qPCR has not.

Kristi

From: Taylor, Nathan
Sent: December-11-17 12:50 PM
To: Miller-Saunders, Kristi
Subject: bullets?

This about right?

- [REDACTED] recent film showing fish blood being released into B.C. waters from two fish processing plants, and subsequent testing of these samples at the Atlantic Veterinary College showing that the effluent contains Piscine Reovirus (PRV) produced a follow-up request for analysis by DFO Science.
- Environment and Climate Change Canada as well as the provincial Ministry of Environment & Climate Change Strategy requested DFO's Molecular Genetics lab to apply their molecular assay for PRV to newly collected environmental samples at Brown's Bay Packing in Campbell River and Lion's Gate Fisheries in Tofino in order to determine the presence of absence of PRV in the effluent. The Section Head for the Molecular Genetics Group agreed to do this testing in consultation with the UBC's Marine Virology and Microbiology laboratory.
- The requests came from Ken Russell, Senior Enforcement Officer - Enforcement Branch Environment and Climate Change Canada, and Laura Hunse, and Environmental Protection Officer, Compliance Section, Environmental Protection Division, Ministry of Environment and Climate Change Strategy (BC).
- The samples were collected on Dec.4 2017 at the Brown's Bay Packing Co, in Campbell River and on Dec 5-6 at Lion's Gate Fisheries, in Tofino BC.
- The samples have not yet been processed, and the results have not been reported back the requestors.
- The Deputy Minister of the BC Ministry of Environment and Climate Change Strategy is eager to know the timeline for the results

Nathan G. Taylor, Ph.D.

Division Manager | Directeur de secteur

Aquatic Diagnostics Genomics and Technology Division | Division des diagnostics, la genomique, de la technologie aquatique

Fisheries and Oceans Canada | Pêches et Océans Canada

Pacific Biological Station | Station biologique du Pacifique

250-756-7395

s.19(1)

Miller-Saunders, Kristi

From: Brian Riddell <briddell@PSF.CA>
Sent: December-11-17 7:56 PM
To: Miller-Saunders, Kristi
Subject: RE: Jaundice in situ talk to BCSFA

Sorry, I should also have said t [REDACTED]

From: Miller-Saunders, Kristi [<mailto:Kristi.Saunders@dfo-mpo.gc.ca>]
Sent: December 11, 2017 7:51 PM
To: Brian Riddell <briddell@PSF.CA>
Subject: Jaundice in situ talk to BCSFA

We also gave a similar talk on HSMI. I need to make it small enough to send. However, the BC department of Environment has asked for a copy of this talk, which I discussed with them in relation to the work we are doing on the bloodwater. They wanted to know what we knew about risk to wild salmon.

Kristi

s.19(1)

Miller-Saunders, Kristi

From: Miller-Saunders, Kristi
Sent: December-11-17 9:10 PM
To: Lowe, Carmel
Subject: FW: PRV Sampling
Attachments: BCSFA_Jaundice Talk KM-ED Nov 28, 2017_Shortened-Comp.pptx

Here is what I sent to the BC Ministry of the Environment. Before we release the PRV testing results, I will have a conversation with them about how they might use this information in their aquaculture review and whether DFO can be of any further assistance, as requested.

Kristi

From: Miller-Saunders, Kristi
Sent: December 11, 2017 8:47 PM
To: Austin, Joyce ENV:EX; Tabata, Amy; Tesch, David ENV:EX; 'Russell, Ken (EC)'
Cc: Hunse, Laura A ENV:EX; McRae, Jake (EC)
Subject: RE: PRV Sampling

Joyce,

Enclosed is the talk I gave at a BC Salmon Farmers Association meeting on PRV-HSMI state of knowledge workshop December 4th- 5th attended by Norwegian scientists, industry vets and leaders, BC and US Scientists, and DFO regulators. The talk outlines the most recent research out of my lab on PRV and linkages with disease in Pacific salmon. I apologize that it is long and pretty scientific, but they key points are:

We have demonstrated that PRV infections in Chinook salmon can induce a host response that we have shown previously to be diagnostic of the presence of viral disease. This work was published in Conservation Physiology this year.

We demonstrate that 14% of moribund/dead farmed Chinook salmon on the west coast obtained through the DFO audit program were diagnosed with jaundice/anemia, a disease that around the world has been associated with various strains of PRV. There is only a single strain of PRV in BC, that which is known to cause HSMI in Atlantic salmon. We published on HSMI in BC farmed Atlantic salmon in Feb. 2017 in PlosOne.

We show that throughout the developmental pathway of jaundice and across multiple affected tissues, PRV is localized within the regions and cells that become diseased, whether disease is through cell death (necrosis) in liver and kidney or inflammation in heart. We gave a similar talk on HSMI in Atlantic salmon and also demonstrated PRV localized with inflammatory lesions in heart and skeletal muscle tissue.

The primary infective tissue for PRV in both species is the red blood cells (which is why blood water from farmed fish is potentially a strong risk for PRV transmission to wild fish). We show that while PRV remains exclusively in the blood, even at high levels, it is tolerated and there is no disease response in the host. When the virus leaves the blood cells to infect other tissues/cells, it induces a disease response in the host.

The difference between HSMI in Atlantic salmon and jaundice/anemia in Chinook salmon is that in HSMI, PRV appears to leave the red blood cells without lysing (rupturing) them, whereas in Chinook salmon, there is massive lysis of red blood cells leading to anemia (pale gills and tissues) and overloading the kidney and liver with Heme from the breakdown of hemoglobin. Heme is processed in kidney and liver, but becomes toxic at high levels, leading to necrosis (death) of kidney tubules and hematocytes (liver cells), and a jaundice (yellowing) appearance in the fish. While we show that the virus also directly infects these cells, we suspect the heme overload, caused by PRV lysis of red blood cells, is likely the main mechanism leading to disease in jaundice fish. Liver and kidney are not highly affected in HSMI in Atlantic salmon, as the virus goes on to infect muscle cells (heart and skeletal) causing inflammation. This inflammatory response is present, but much reduced in Chinook salmon with jaundice.

We have also demonstrated early (jaundice) disease development in wild Chinook salmon. There was a presentation by Dr. Maureen Purcell at the same meeting that showed an association of the same strain of PRV with a similar disease, which they and the Japanese call EIBS, in Washington State Coho salmon.

I hope this helps in your consideration of the potential for risk in the release of blood water. I am happy to discuss these results directly if there is any need for clarification. We are working up a publication on these data at present.

Kristi Miller-Saunders
Head, Molecular Genetics
Pacific Biological Station

From: Austin, Joyce ENV:EX [Joyce.Austin@gov.bc.ca]
Sent: December 11, 2017 10:58 AM
To: Tabata, Amy; Tesch, David ENV:EX; 'Russell, Ken (EC)'
Cc: Hunse, Laura A ENV:EX; McRae, Jake (EC); Miller-Saunders, Kristi
Subject: RE: PRV Sampling

Hi Amy,

I have already contacted Kristi Miller and I'm waiting on her to give me a call back,

Thanks

Joyce Austin, Ph.D.
Senior Provincial Laboratory Specialist (Unit Head)
Environmental Monitoring, Reporting & Economics
Knowledge Management Branch | Ministry of Environment & Climate Change Strategy
Mailing address : PO Box 9347 STN PROV GOVT, Victoria, BC V8W 9M1
Physical address : 525 Superior St, Victoria, BC V8V 1T7
Tel.: 778-698-4434;
Cel.: 
Fax: 250-356-7197

From: Tabata, Amy [mailto:Amy.Tabata@dfo-mpo.gc.ca]
Sent: Monday, December 11, 2017 10:55 AM
To: Tesch, David ENV:EX; 'Russell, Ken (EC)'
Cc: Austin, Joyce ENV:EX; Hunse, Laura A ENV:EX; McRae, Jake (EC); Miller-Saunders, Kristi
Subject: RE: PRV Sampling

We are currently processing the samples, and expect results in the next few days.

Please contact

Dr Kristi Miller – Head – Molecular Genetics Lab, cc'd above or by phone at 250-756-7155

Thanks

Amy Tabata
Molecular Genetics Technician
Fisheries and Oceans, Canada
Pacific Biological Station
3190 Hammond Bay Road

s.16(2)(c)

Nanaimo, B.C. V9T 6N7
ph. 250-756-3369
fax 250-756-7031
email amy.tabata@dfo-mpo.gc.ca

From: Tesch, David ENV:EX [<mailto:David.Tesch@gov.bc.ca>]
Sent: December-11-17 10:35 AM
To: 'Russell, Ken (EC)'
Cc: Austin, Joyce ENV:EX; Hunse, Laura A ENV:EX; Tabata, Amy; McRae, Jake (EC)
Subject: RE: PRV Sampling

Thanks Ken,

I've been able to get a hold of Joyce and she is going to give DFO a call.

Regards,
D.

From: Russell, Ken (EC) [<mailto:ken.russell@canada.ca>]
Sent: Monday, December 11, 2017 10:29 AM
To: Tesch, David ENV:EX
Cc: Austin, Joyce ENV:EX; Hunse, Laura A ENV:EX; Tabata, Amy (Amy.Tabata@dfo-mpo.gc.ca); McRae, Jake (EC)
Subject: RE: PRV Sampling

Good morning David,

I am not sure of the analysis time line for the PRV. Your best contact at this point in time would be Laura Hunse – who is in contact with Amy Tabata. Ms. Tabata is the DFO molecular geneticist technician who accompanied us during the sampling. I have CCed Ms. Hunse and Ms. Tabata on this Email.

I hope this helps

Ken Russell
Senior Enforcement Officer – Enforcement Branch
Environment and Climate Change Canada / Government of Canada
ken.russell@canada.ca / Tel : 250 756 7251 / Cell : [REDACTED]

Ken Russell,
Agent d'application de la loi Supérieur, Direction générale de l'application de la loi
Environnement et Changement Climatique / Gouvernement du Canada
ken.russell@canada.ca / Tel. : 250 756 7251 / Tel. Cell : [REDACTED]

From: Tesch, David ENV:EX [<mailto:David.Tesch@gov.bc.ca>]
Sent: December 11, 2017 9:12 AM
To: Russell, Ken (EC)
Cc: Austin, Joyce ENV:EX
Subject: PRV Sampling
Importance: High

s.16(2)(c)

Hi Ken,

My name is David Tesch and I am Joyce's Executive Director. Joyce is not in the office today and my DM is asking if there is an ETA on the results from the PRV sampling that was done at the fish farms early last week. Are you able to provide me an answer?

Regards,
David Tesch
Executive Director
Knowledge Management Branch
Ministry of Environment & Climate Change Strategy
778-698-4406
David.Tesch@gov.bc.ca

Field manifestation of Jaundice in farm audit Chinook salmon: insights into PRV involvement in disease development

Kristi Miller, PhD

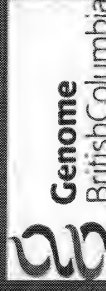
Emiliano Di Cicco DVM PhD

Fish Health Researcher

PSF - DFO



Fisheries and
Oceans Canada






Preface

HSMI in Atlantic salmon:

- Worldwide, HSMI outbreaks have always occurred in association with PRV-I; PRV is both statistically and spatially associated with developing lesions
- The cause and effect relationship between PRV-I and HSMI was definitively established in Norway in 2017 (Rimstad's talk)
- Genome sequencing shows that the strain of PRV in BC salmon is >97% identity with that causing HSMI in Norway (PRV-Ia)
- HSMI was recently reported on a salmon farm in BC, with inflammatory lesions in >80% of the farm population, and showing the same linkage with PRV as observed in other farm outbreaks
- HSMI lesions have also been observed in farm audit samples, suggesting that the disease is not limited to this one farm.
- If PRV causes HSMI in Norway, it causes HSMI in BC; not scientifically defensible that another agent would be the cause here than in Norway...especially given the high identity of BC and Norwegian agents

It is imperative now that research focus on understanding the disease development pathway and triggers, transmission and risk to wild salmon




Preface

Jaundice in Pacific Salmon:

- Outbreaks of diseases in Pacific salmon characterized by inclusion bodies (EIBS), jaundice, anemia, and often mild, transitory HSMI-like heart lesions have been observed in Norway, Chile, and Japan in association with various strains of PRV
- A cause and effect relationship (using purified virus) has been established between PRV-2 and the disease in Coho salmon
- A challenge study with PRV-3 was able to emulate the heart lesions in Norwegian Rainbow Trout, but a cause and effect relationship was not established (tissue homogenate)
- In Chile, challenge studies have not yet taken place, but outbreaks of disease in Coho salmon have occurred in association with PRV-3 (and possibly PRV-I)
- In BC, despite extensive sequencing, only one strain of PRV has been found, PRV-Ia, which causes HSMI in Atlantic salmon
- However, BC Chinook salmon show the same disease manifestation as observed in farmed Coho and Rainbow trout, but in this case, in association with the same strain of PRV that causes HSMI (PRV-I).

Research on Chinook salmon from audit samples is beginning to elucidate the role of PRV-Ia in the disease development pathway providing critical data for PRV-risk assessments to Pacific salmon



Outline

Jaundice in Pacific salmon:

- What we can learn from studies around the world
- PRV Prevalence distribution in farmed Chinook salmon
 - Spatial variation of PRV among management zones
- Disease Development
 - Identifying fish in an early stage of disease development
 - Viral disease diagnostic panel application differentiates fish that are PRV carriers vs those with molecular evidence of disease
 - In situ hybridization reveals where the virus is localized during the jaundice disease developmental pathway

Norwegian Rainbow Trout

Disease characterized as HSMI-like

Temporal:

Clinical: anorexia, lethargy, modest to 21% mortality in FW hatchery and up to 4 months after SW transfer (over 6 months)

Gross: haemorrhages, ascites, *anaemia*, bulging eyes, *jaundice* yellow liver

Pathological: All fish showed pancarditis- *especially spongy layer*, some with cardiomyocyte necrosis, degeneration and necrosis of red muscle fibers, fibrosis, vacuolization and *necrosis of hepatocytes*, *haemosiderosis in spleen*, increased circulatory neutrophils in kidney and spleen

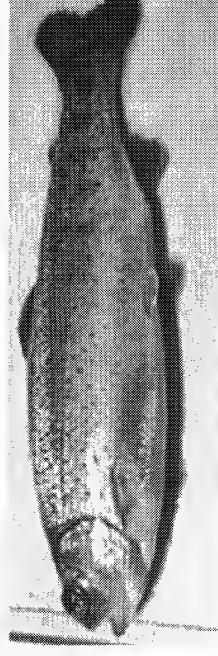
Haematology: reduced haematocrit (22%)

Electron microscopy: no EIBS detected

PRV-3 (Om) strain sequence identified in high load (CT 22) in all affected fish across 5 farms vs. healthy fish from tanks without disease no PRV; live-sampled fish from tanks with disease also had high load detections suggesting that like HSML, disease may occur farm-wide

Suggested next steps: controlled challenge studies, **reveal pathogenesis and assess tissue distribution of PRV at different stages of infection**

Olsen et al. 2015. *PLoS one*, 10(7), p.e0131638.





Norwegian Rainbow Trout

PRV-3 (Om)

IP injection/cohab trial with tissue homogenate showed:

Viral replication in red blood cells in both Atlantic salmon (AS) and Rainbow trout (RT)

Histopathology examination limited to the heart

RT: Cohab peak infection at 6 wks (Ct 23, 80-100% infected), with mild to moderate heart lesions
8 WPI in 1/3rd of fish, strong antiviral response, inclusion bodies observed, ascites, pale gills and hemorrhages

AS: Cohab infection took 8-16 WPI, <50% infected, weak antiviral response, mild focal myocarditis in only a few fish, inclusion bodies, inclusion of hypoxia and crowding stress increased infection rates, but not disease development, weak anti-viral response

PRV-3 behaves more like an acute infection in RT, with viral peak and subsequent clearance, compared to PRV-I infections in AS, which are chronic and long lasting

Study concludes that while AS don't appear to be strongly impacted by PRV-Om, they could be a reservoir for infection of RT!

Suggest that "early antiviral response may play an important role in triggering pathology"

Hauge et al. 2017, *PLoS one*, 12(7), p.e0180293

Chilean Coho salmon

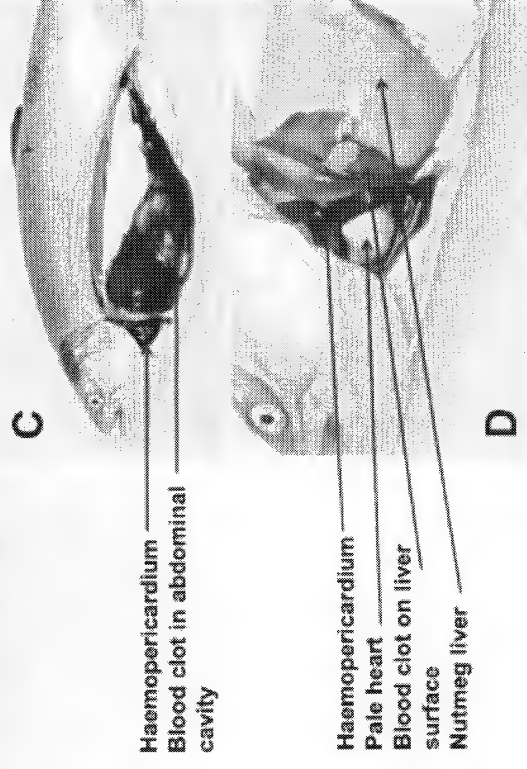
Investigation of PRV-related farm outbreak of disease; “HSMI-like” disease in Coho salmon

Targeted sampling: lethargy and morbidity

Gross: jaundice, pale heart, ascites, blood clots in abdominal cavity

Pathology: Myocarditis restricted to *spongy layer*, minor myositis of red muscle, *major hepatic necrosis* in fish with low Cts, erythrophagocytosis in kidney/spleen

Coho contained a diverse range of PRV genotypes—Ia, Ib, and II
No effort to differentiate the strains associated with lesions



Godoy et al., 2016, Virology J 13: 98

Japanese Coho salmon

Viral purification from EIBS-affected Coho used in challenge study—Novel PRV-2 variant identified as the cause of EIBS in Japanese Coho salmon

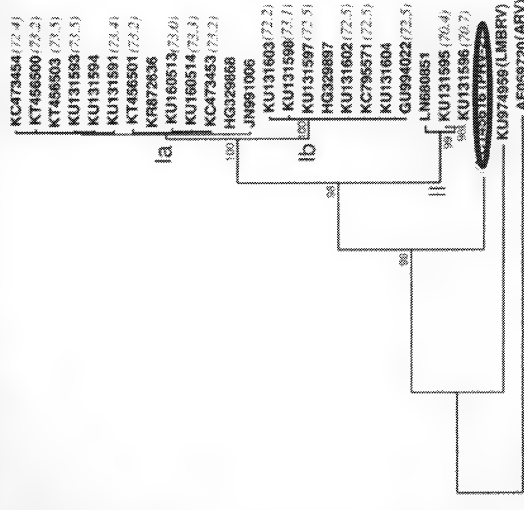
EIBS is traditionally characterized by severe anemia and erythrocytic inclusion bodies, jaundice assumed to be caused by excess bilirubin in the liver

Consistency in pathological changes in Chilean Coho salmon: Yellow liver-jaundice, pale gills, splenomegaly, hemopericardium, epicarditis, myocarditis

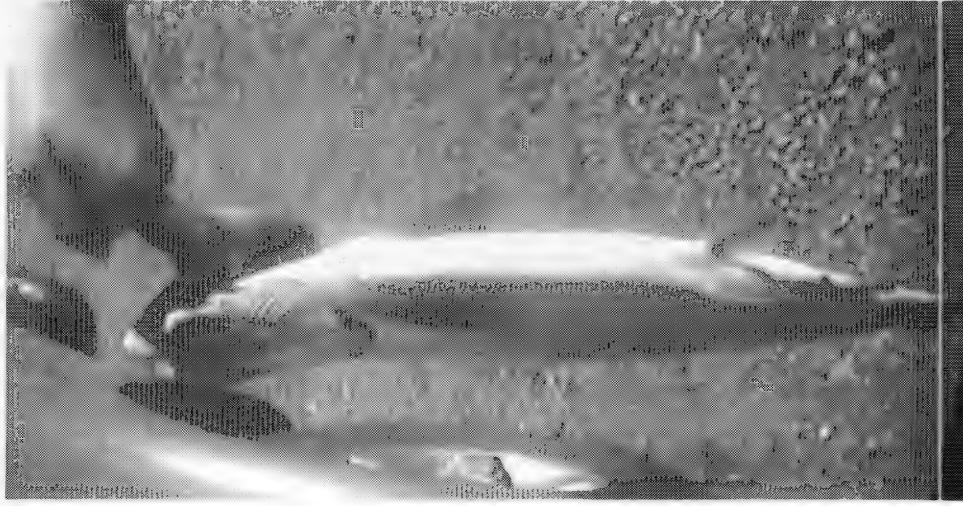
Challenge study showed: High loads of virus and inclusion bodies developed post-challenge in naïve fish, but no significant increase in virus and no EIBS in previously exposed establishing that protective immunity occurs

Farm Epizootic: PRV-2 peak copy numbers in intestine, kidney, liver, muscle and spleen 1 week earlier than in heart, hematocrit decreased coincident increased with PRV-2 load, cumulative mortality of 23%

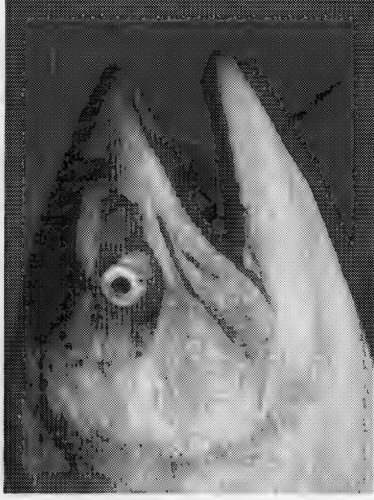
Previous observation that EIBS is a higher risk in fish fed large amounts of food for rapid growth



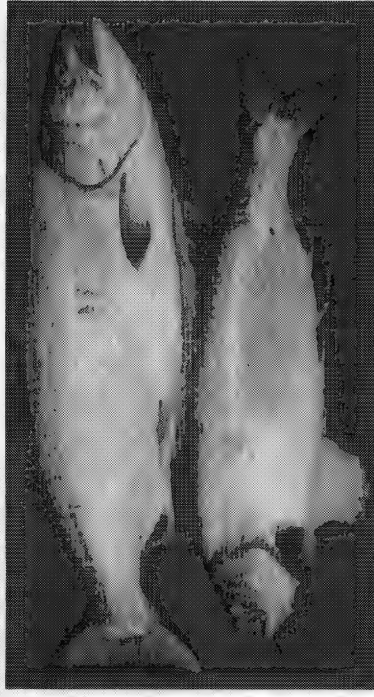
Examples of "Yellow" Jaundice fish caught in the wild



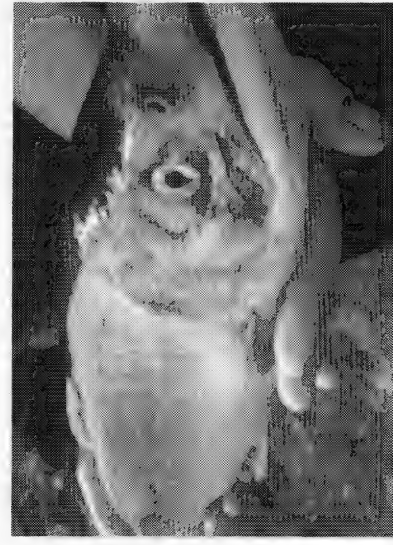
Sockeye salmon
Teshaut FN, Port Alberni
July 2011



Chinook salmon
Newport, Oregon
July 2012



Pink salmon
Fraser River
Fall 2014



Sockeye salmon
Copper River, AK
August 2008



BC Chinook Salmon

Jaundice is described as a recurrent “syndrome” sporadically affecting cultured Chinook salmon

Clinical: off feed

Gross: jaundice, anemia, pale liver

Pathology: *Hepatic necrosis, hepatocellular hydropic degeneration, renal interstitial cell necrosis, splenic parenchymal fibrin*

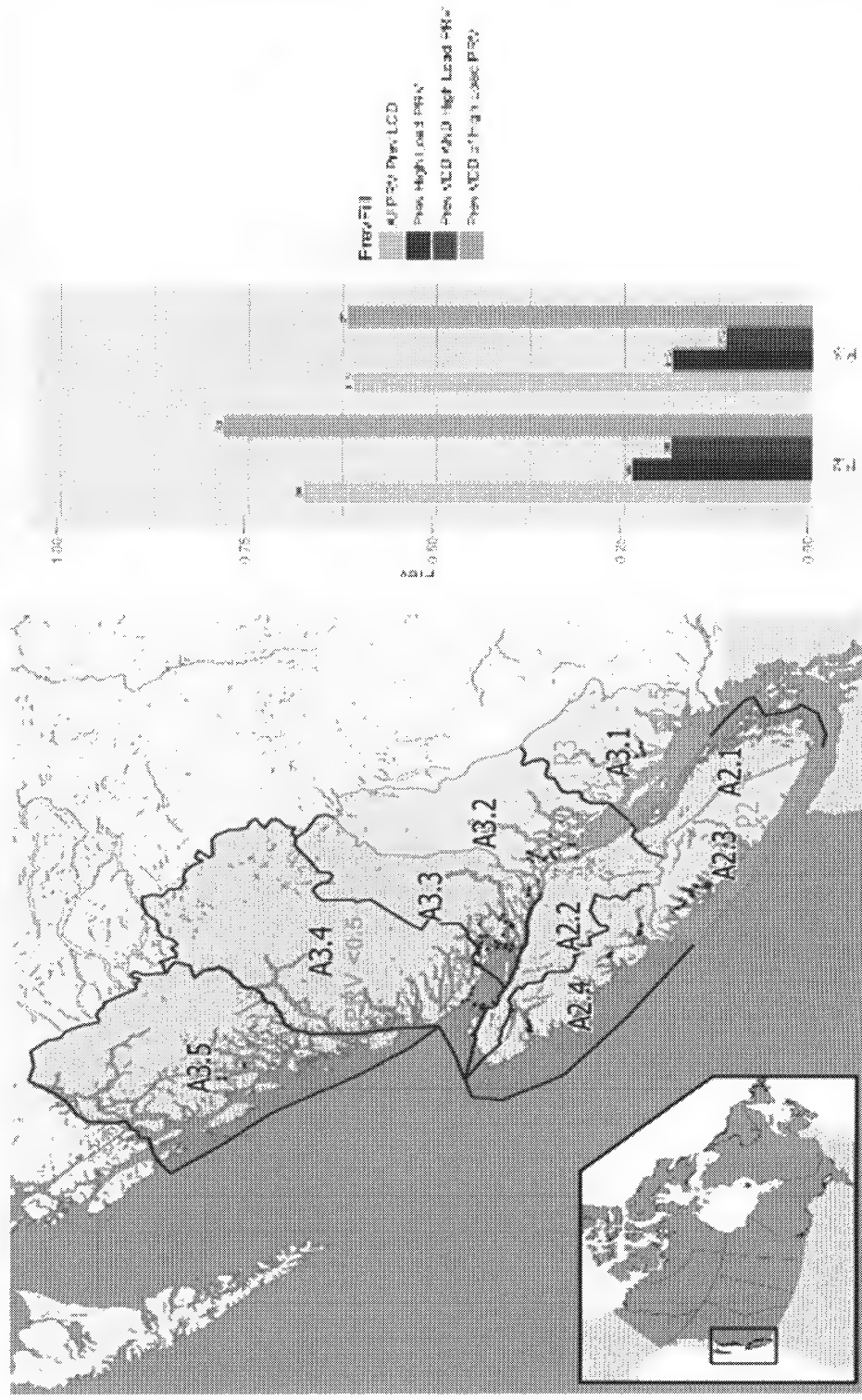


Jaundice in farmed
Chinook salmon
Garver et al. 2015

PRV-1a is the only strain of PRV that has been detected in BC salmon, and all 10 farm-jaundice fish from the Garver study contained high loads of PRV

PRV in relation to Jaundice was actually first detected in my lab in 2011 in a study

93% of Jaundice fish in area P2—West Coast of Vancouver Island



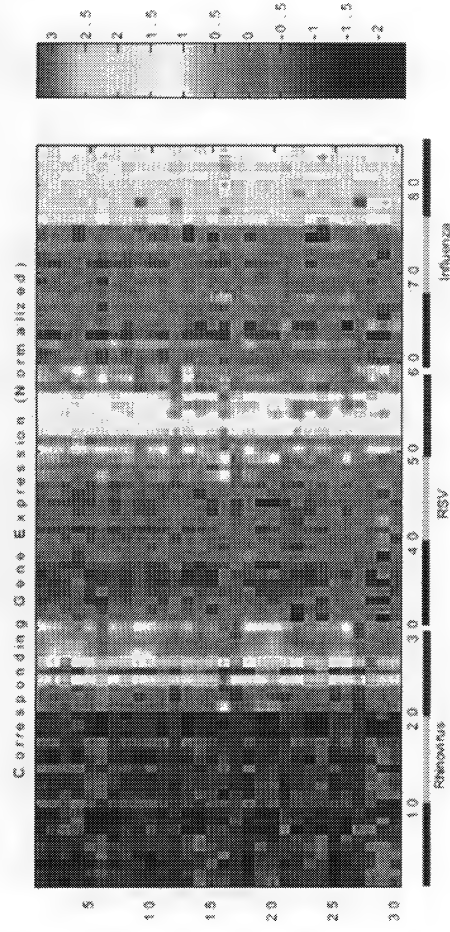
PRV Prevalence Farmed Chinook Salmon



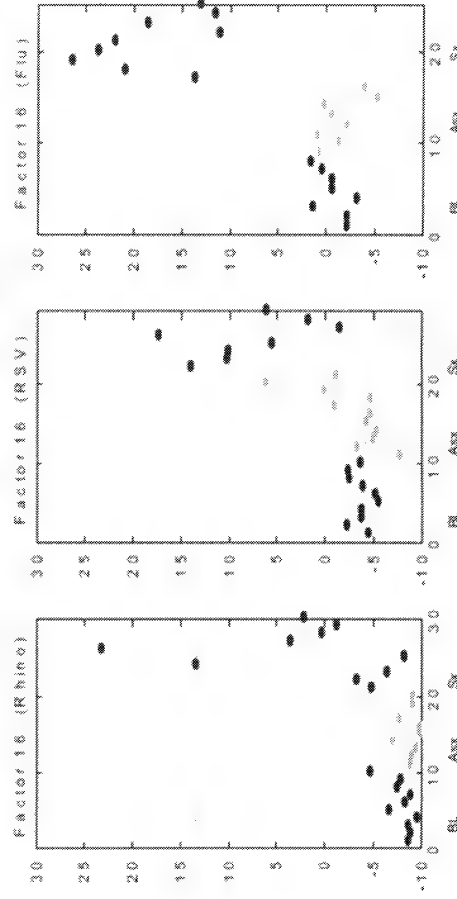
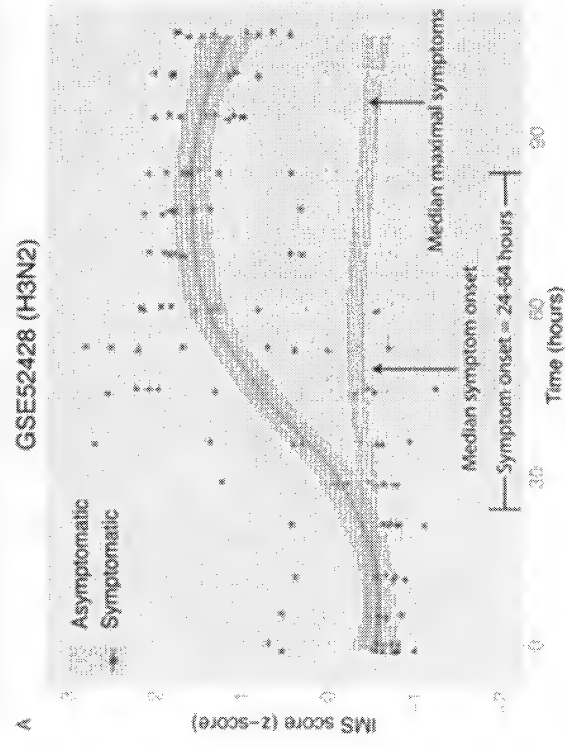
The role of PRV in the development of Jaundice can be substantiated by:

- 1) employment of a novel, highly sensitive molecular tool to recognize early stages of viral disease development
- 2) employment of *in situ* hybridization to localize PRV within tissues of fish developing jaundice

Molecular Viral Disease Diagnostic (VDD) biomarkers in humans



Highly sensitive panel of host biomarkers diagnostic of human viral disease



— baseline

— asymptomatic

— symptomatic

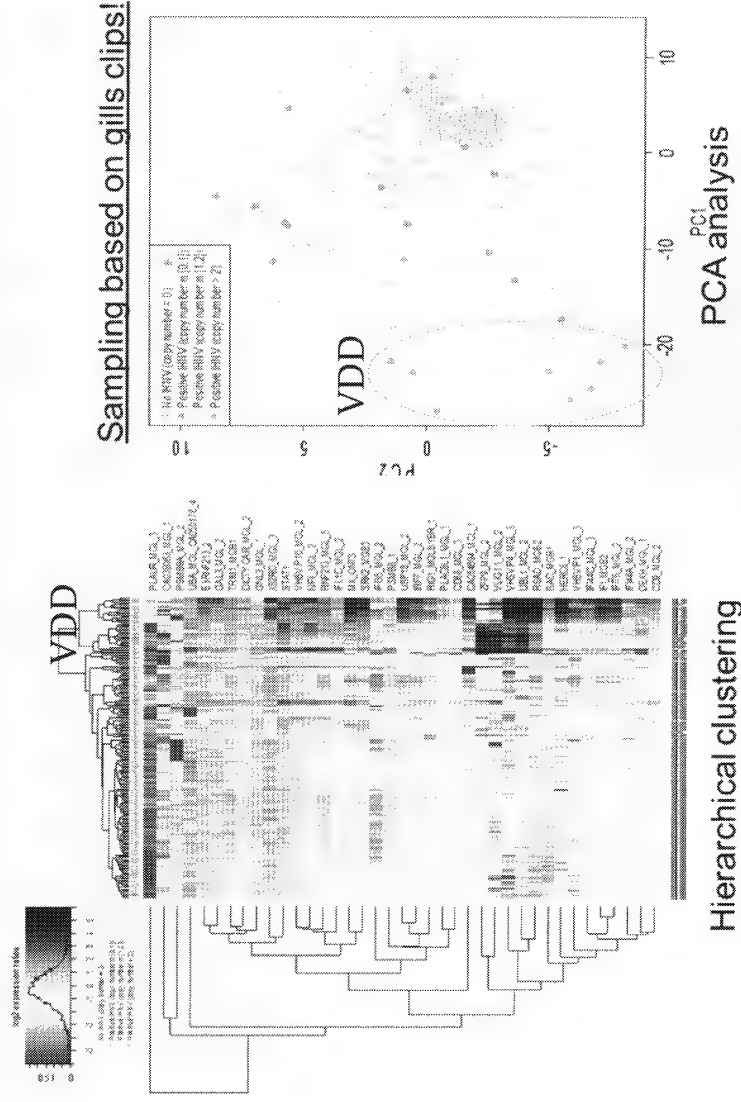
Zaas et al., 2009 "Gene Expression Signatures Diagnose Influenza and Other Symptomatic Respiratory Viral Infections in Humans" Cell Host & Microbe 6, 207–217

Molecular Viral Disease Diagnostic (VDD) biomarkers in Salmon

Similar approach taken to develop a panel of viral disease biomarkers for salmon predictive of viral disease from emanating from any RNA virus

ISAV, PMCV, IPNV, IHNV, PRV, and others..., and a range of tissues

Most wild migrating sockeye salmon smolts with high IHNV loads "VDD"



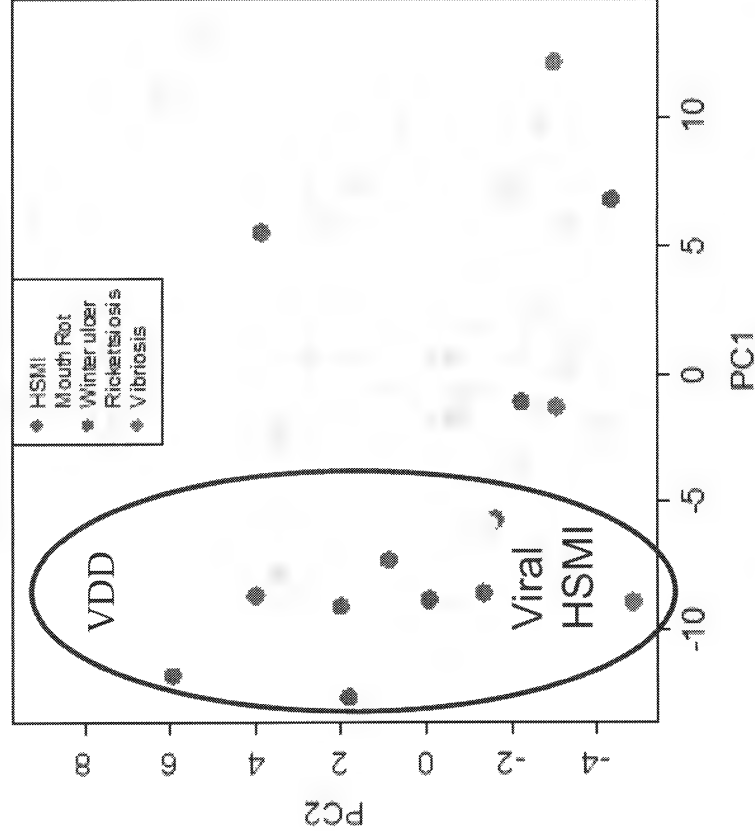
Miller et al. 2017 Conservation Physiology 5(1)



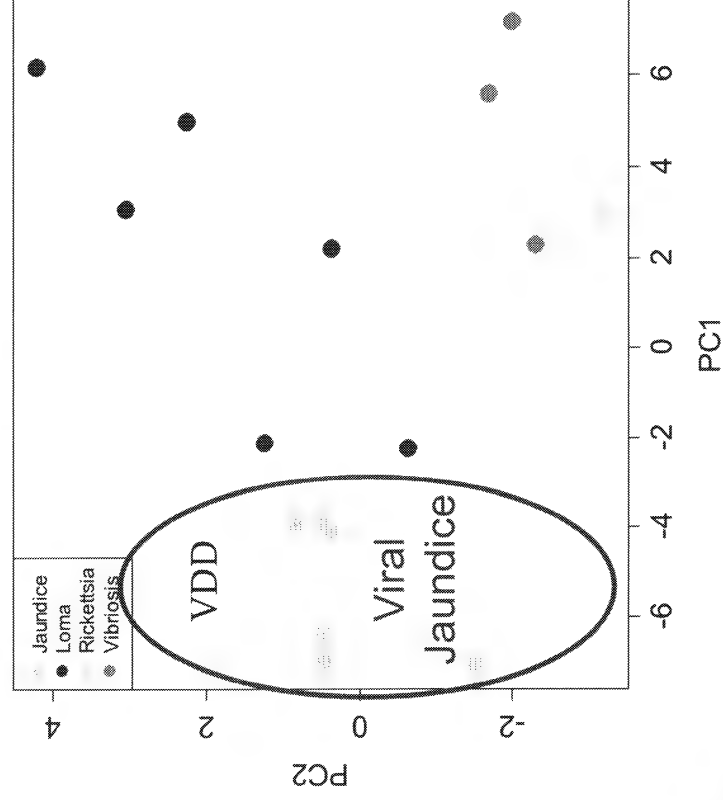
Molecular VDD biomarkers – early disease detection

PRV-related viral diseases in both Atlantic and Chinook salmon audits differentiated by VDD

Atlantic Salmon



Chinook Salmon



Molecular VDD biomarkers – Piscine Orthoreovirus

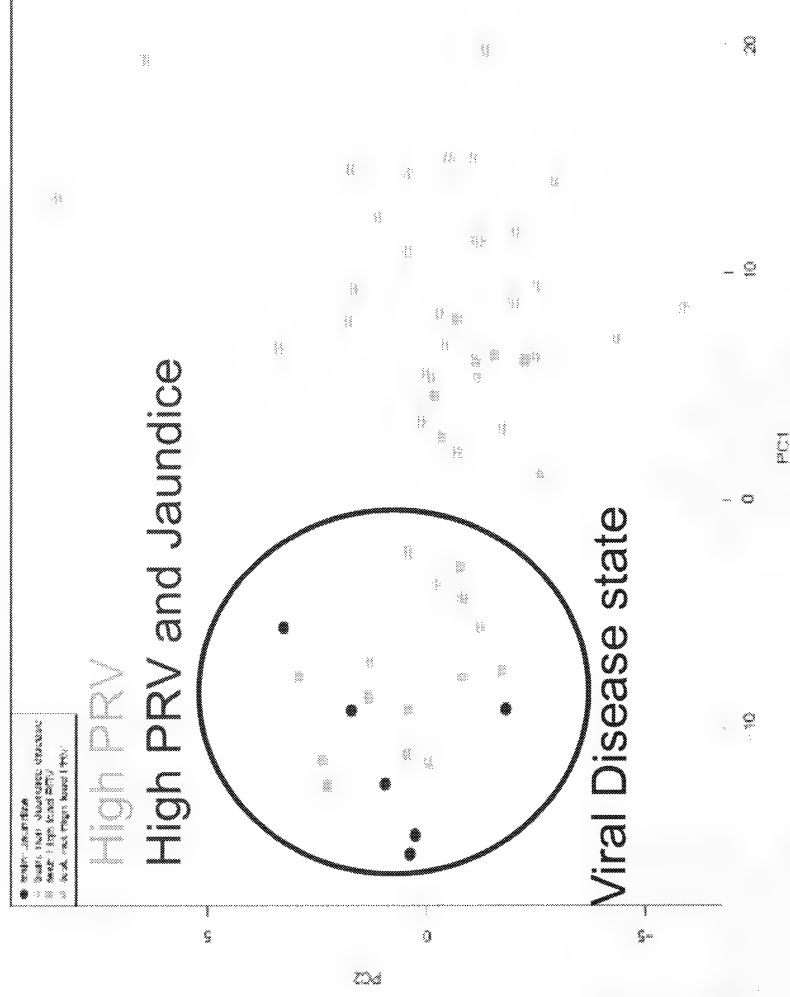
Farmed Chinook salmon audits

80% of farmed Chinook salmon with **high loads** of PRV are in a “viral disease state”

50% of which were diagnosed with jaundice/anemia

Novel viruses discovered in VDD “unknowns”

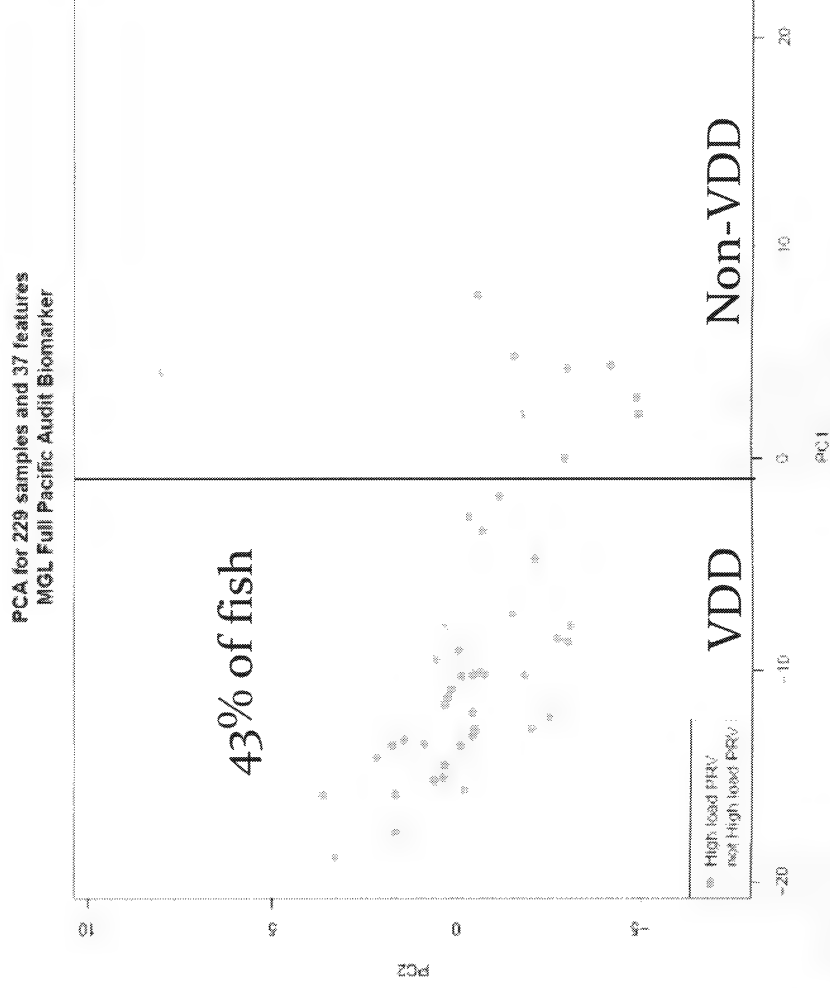
PCA for 17 training samples used to predict
40 All Diseases samples (MGL Pacific Audit Biomarker)



Molecular VDD biomarkers – Piscine Orthoreovirus

Farmed Chinook salmon

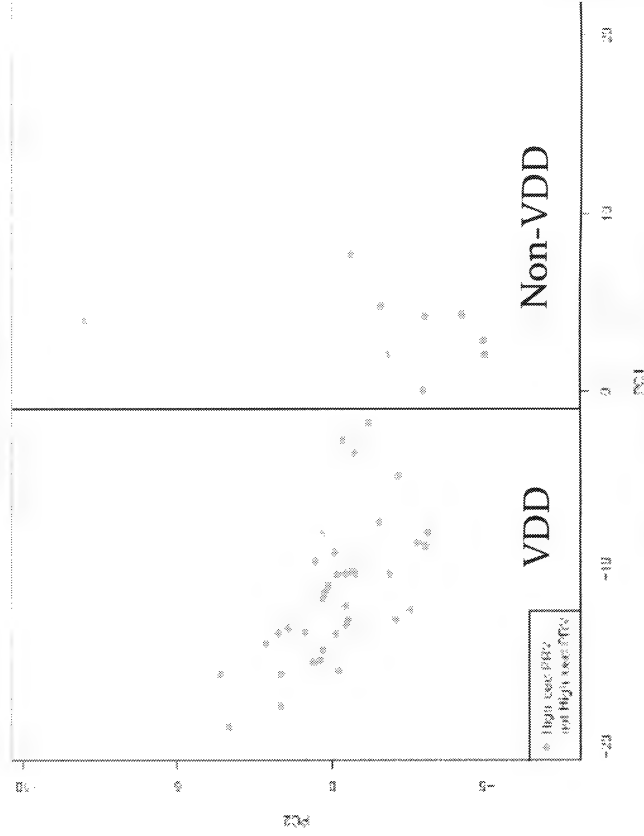
43% of dying Chinook salmon are in a VDD state—65% with unknown viral associations



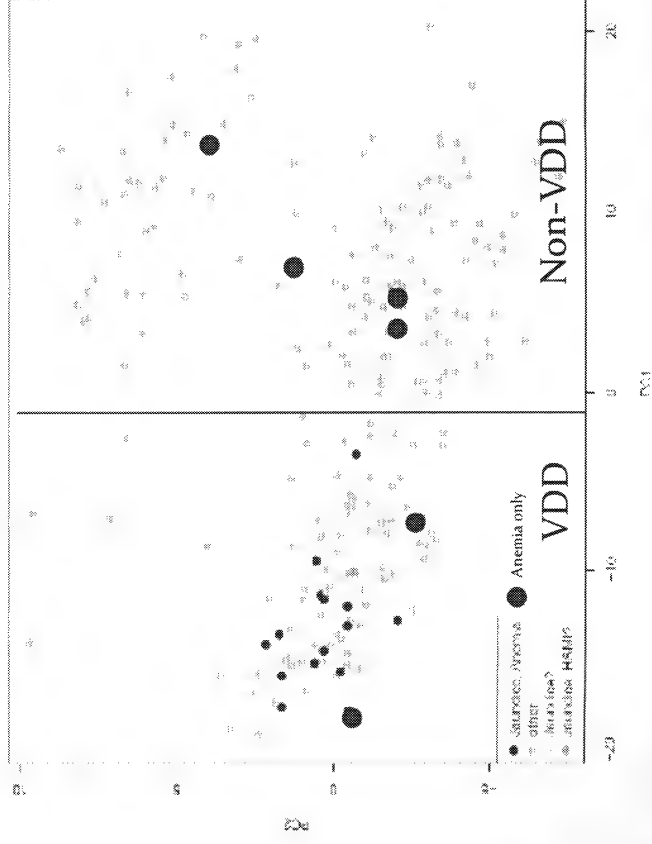
Association of PRV with Jaundice in Chinook salmon

>5% of audit Chinook salmon dying with jaundice, 14% on the west coast alone
All fish characterized with jaundice carry high loads of PRV, and all are classified as VDD
While many jaundice fish also have anemia, not all fish characterized only with anemia fit this pattern
(●)

PCA for 229 samples and 37 features
MGL Full Pacific Audit Biomarker



PCA for 229 samples and 37 features
MGL Full Pacific Audit Biomarker

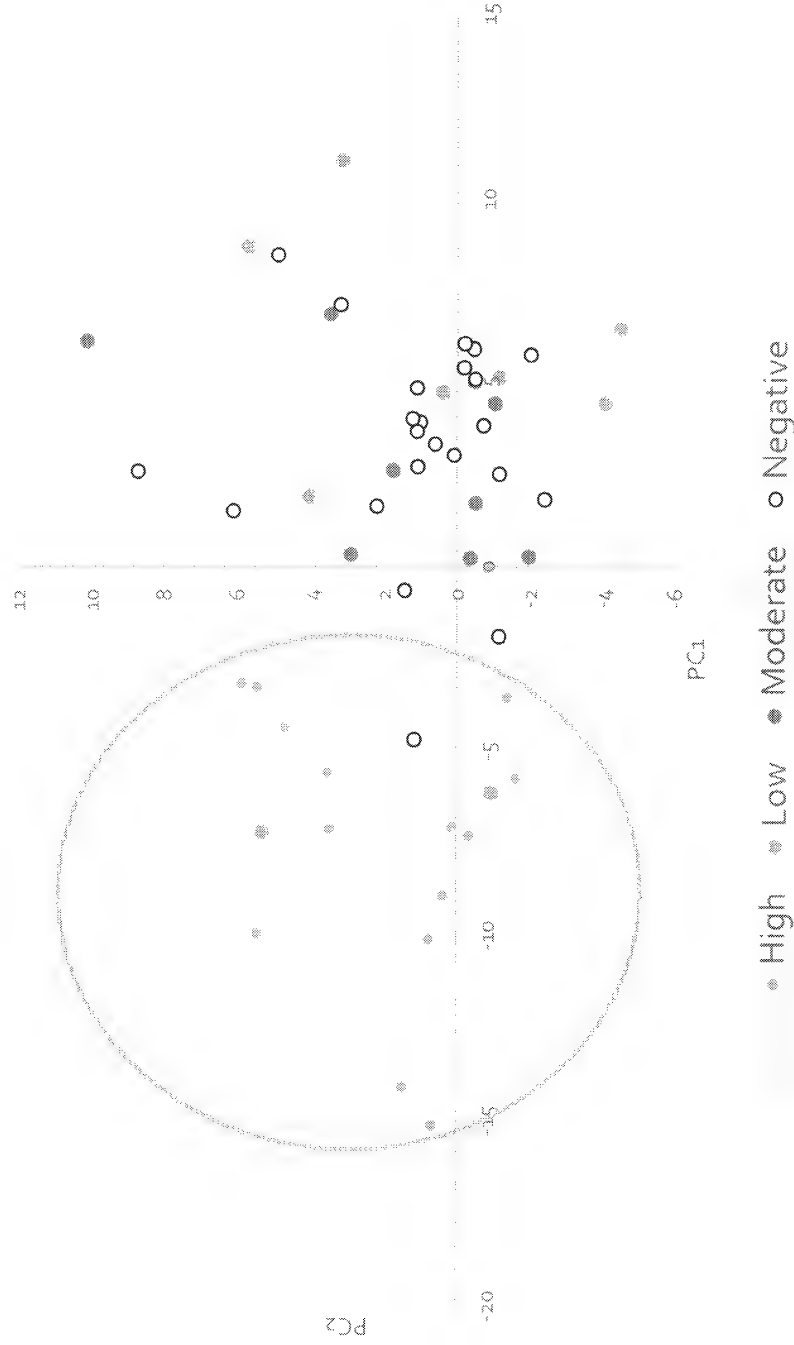


Molecular VDD biomarkers – Piscine Orthoreovirus

Wild Chinook Salmon

93% of Wild Chinook juveniles containing high loads of PRV are in a “viral disease state”

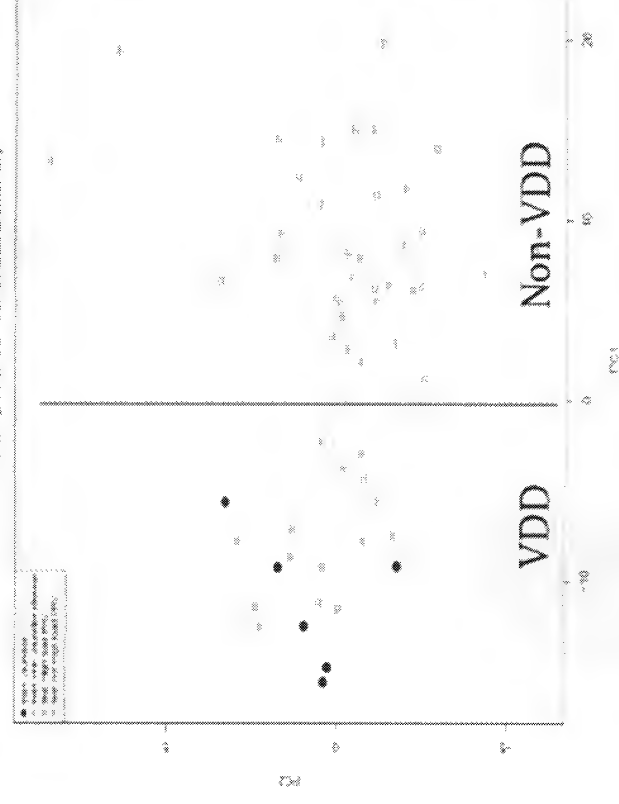
VDD Chinook Smolts by PRV load



The molecular viral disease diagnostic (VDD) panel offers a unique opportunity to study disease development pathways both in laboratory and field applications—given its ability to differentiate viral carriers from active disease states, and to identify individuals at an early (pre-clinical) stage of disease development

Clinical disease (PRV+/VDD+/Jaundice+)
 Pre-clinical (PRV+/VDD+/Jaundice-)
 Carrier (PRV+/VDD-/Jaundice-)

PCA for 17 training samples used to predict 40 AH Disease samples (MGL Pacific Audit Biomarker)





In-Situ Hybridization for PRV-1a

By detecting the localization of PRV in farmed Chinook salmon collected
for the DFO - Audit program

**we want to better understand the development pathway of
Jaundice/Anemia**

Jaundice → 1. PRV+
2. PRV+/VDD
3. PRV+/Jaundice

Liver – Kidney – Spleen – Intestine – Heart

LIVER

PRV (red) in the RBCs (arrows)

PRV+

In absence of VDD or jaundice,
PRV remains in the blood where
it is known to replicate

100 µm

LIVER

PRV (red) in the RBCs (arrows)
and hepatocytes

PRV+/VDD

In fish classifying as VDD+
(in a viral disease state)
there is evidence that PRV
has begun to infect other
Tissues—here the hepatocytes,
where there is also evidence of
necrosis

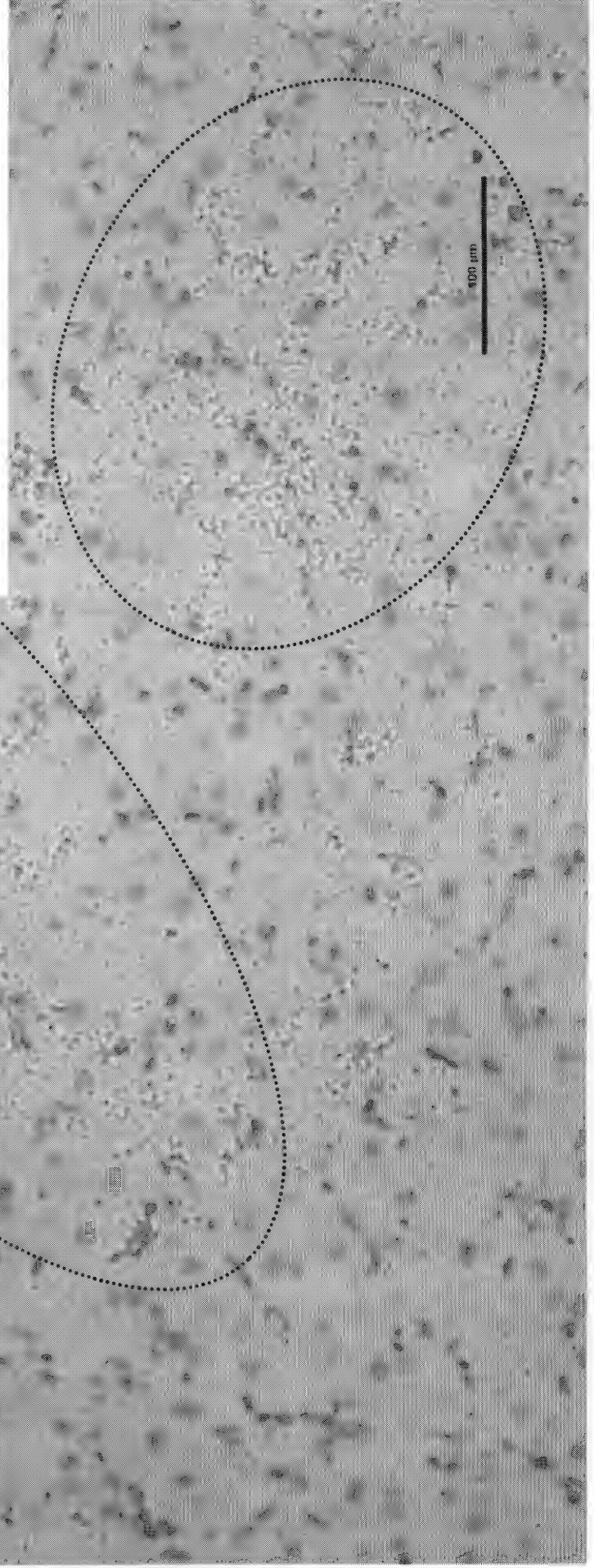


LIVER

PRV (red) in
damaged and necrotic
hepatocytes (arrowheads)

PRV+/VDD

In fish classifying as VDD+
(in a viral disease state)
there is evidence that PRV
has begun to infect other
Tissues—here the hepatocytes,
where there is also evidence of
necrosis



LIVER
PRV (red) in
the damaged hepatocytes

PRV+/Jaundice

In fish classifying as Jaundice
(all also VDD) the virus
continues to be associated with
expansive areas of liver
necrosis

500 µm

LIVER

PRV (red) in
the damaged hepatocytes

PRV+/Jaundice

In fish classifying as Jaundice
(all also VDD) the virus
continues to be associated with
expansive areas of liver
necrosis

100 µm

LIVER

PRV (red) is initially present in the RBCs only, while it moves in hepatocytes in the VDD phase, and localizes in the necrotic lesions as Jaundice develops

100 µm
PRV+

PRV+/VDD

PRV+/Jaundice

KIDNEY

PRV (red) in macrophages
and MMCs (arrows)

PRV+

In absence of VDD or jaundice,
PRV remains in the blood and in
macrophages engulfing blood cells
in the kidney

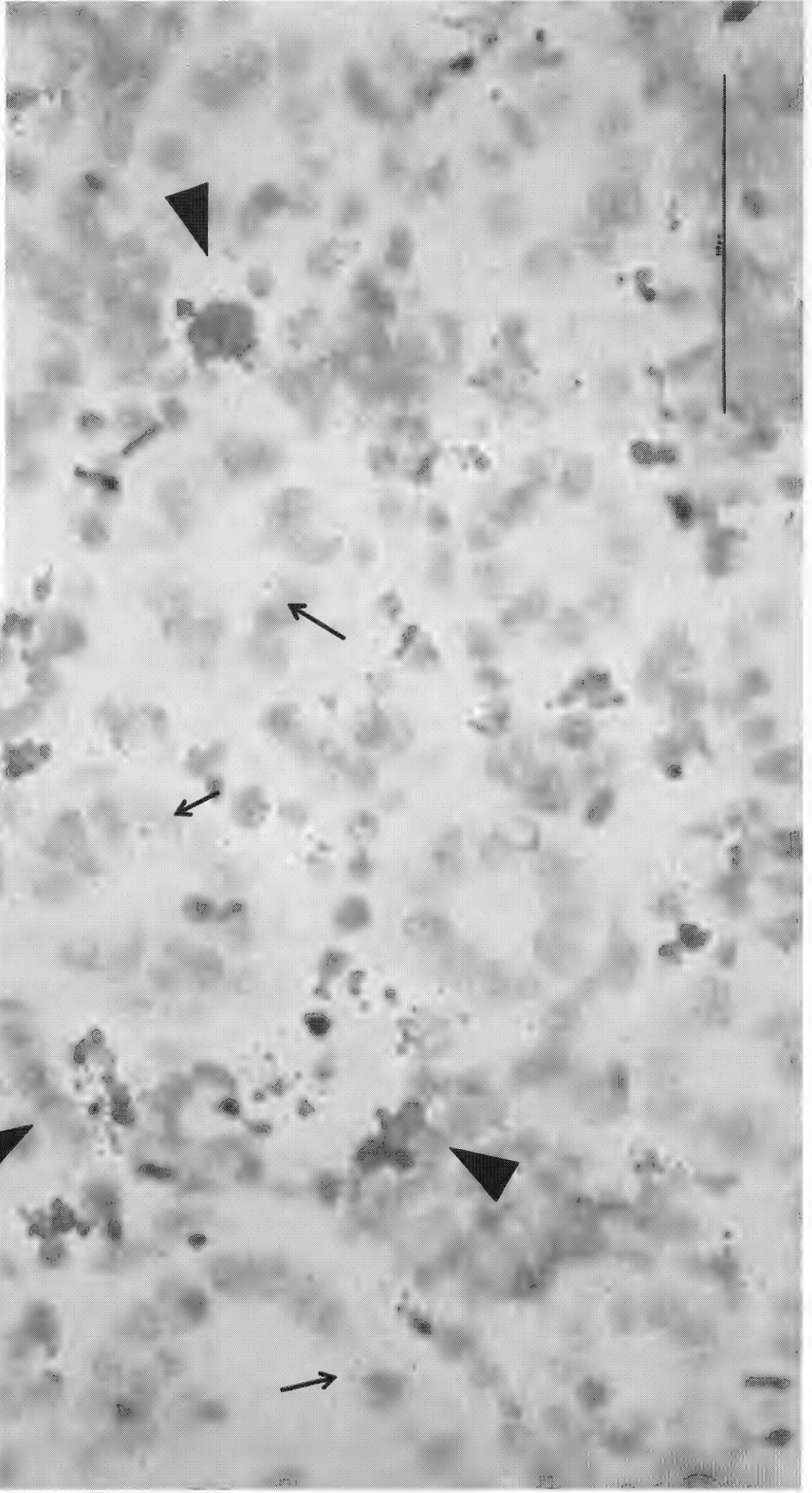
100 µm

KIDNEY

PRV (red) in macrophages
and MMCs (arrowheads)

PRV+

In absence of VDD or jaundice,
PRV remains in the blood and in
macrophages engulfing blood cell
around the kidney tubules



PRV +/VDD

In fish positive for VDD but not jaundice, PRV continues to be strong in macrophages but also starts infecting kidney tubules which are becoming necrotic (*)

KIDNEY

PRV (red) in macrophages and MMCs (arrowheads), and in the necrotic material inside the renal tubules (arrows)

100 µm

PRV+/Jaundice

KIDNEY

PRV (red) in macrophages and
MMCs (arrowheads),
and in the necrotic
material inside the renal
Tubules (arrows)

In fish with jaundice, PRV continues to be strong in macrophages surrounding kidney tubules but also infects kidney tubules themselves, many of which are now necrotic (*)

100 μ m

KIDNEY

PRV (red) localizes in the macrophages cells, mostly around the tubules, as well in the epithelial cells of the tubules and in the necrotic material inside the damaged tubules

PRV+

PRV+/VDD

PRV+/Jaundice

SPLEEN

**PRV (red) in the Macrophages,
MMC and RBCs**

PRV+

In absence of VDD or jaundice,
PRV remains in the blood
running through the spleen

500 µm

SPLEEN

PRV (red) in the Macrophages,
MMC and RBCs in sinuses (arrows)

PRV+/VDD

In fish positive for VDD but not jaundice,
there is evidence of massive blood cell
lysis in the spleen, releasing large
amounts of virus engulfed by
macrophages and MMCs

500 µm

SPLEEN

PRV (red) in the Macrophages,
MMC and RBCs

PRV+/Jaundice

In fish with jaundice, the spleen carries massive levels of PRV within macrophages and infecting other cells

100 µm

SPLEEN

PRV (red) is initially present in the RBCs, then the macrophages and

MMCs start phagocytosing the damaged cells, to the point to engulf the organ during the

Jaundice phase

PRV+

PRV+/VDD

PRV+/Jaundice

INTESTINE

PRV (red) in the RBCs (arrows)

PRV+

In absence of VDD or jaundice,
PRV remains largely in the
blood running through the
intestine

100 µm

INTESTINE

PRV (red) in the RBCs (arrowheads)
and enterocytes (arrows)

PRV+/VDD

In fish positive for VDD but not jaundice,
Virus moves out of RBCs and infects
enterocytes of the intestine. This may be
a route of viral exit

100 µm

INTESTINE

PRV (red) in the RBCs (arrowheads)
and enterocytes (arrows)

PRV+/Jaundice

In fish with jaundice, PRV continues to infect enterocytes of the intestine. This may be a route of viral exit

100 µm

INTESTINE

PRV (red) is initially the RBCs only,
but it localizes also in the
enterocytes in the VDD and
Jaundice phases

PRV+

PRV+/VDD

PRV+/Jaundice

HEART

PRV (red) in RBCs (arrows)

PRV+

In absence of VDD or jaundice,
PRV remains in RBCs in the
heart

Spongy
Myocardium

Epicardium

Compact Myocardium

500 μ m

PRV+ /VDD

Epicardium

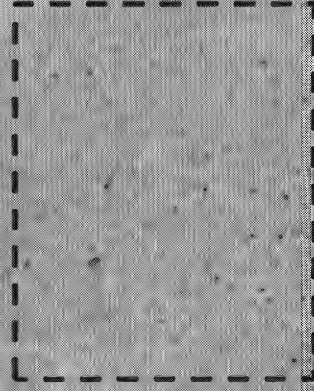


Compact Myocardium

HEART

PRV (red) in RBCs and cardiomyocytes, mostly in the spongy myocardium, and associated to endo/myocarditis

In fish with VDD but not yet jaundice, as in Atlantic salmon, PRV moves out of the RBCs and begins infecting cardiomyocytes



Spongy
Myocardium

HEART

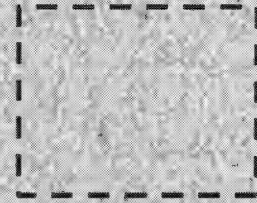
PRV+ / VDD

PRV (red) in RBCs and cardiomyocytes, mostly in the spongy myocardium, and associated to endo/myocarditis

Epicardium



In fish with VDD but not yet jaundice, as in Atlantic salmon, PRV moves out of the RBCs and begins infecting cardiomyocytes, concentrating in areas of mild inflammation



Spongy Myocardium

Compact Myocardium

500 µm

500 µm

HEART (Spongy)

PRV (red) in RBCs
and cardiomyocytes (arrowheads)

PRV+ /VDD



In fish with VDD but not yet jaundice, as in Atlantic salmon, PRV moves out of the RBCs and begins infecting cardiomyocytes, concentrating in areas of mild inflammation

100 µm

Atlantic Heart (HSMI)

Chinook Heart (PRV+MI)

Spongy
Myocardium

Epicardium

Both Atlantic and Chinook salmon hearts become inflamed during PRV infection, but whereas inflammation becomes severe impacting the entire heart for a prolonged period of time in HSMI, in Chinook salmon, inflammation is fleeting and primarily restricted to the spongy myocardium, where the virus is concentrated

Epicardis

Compact Myocardium

Compact Myocardium

Spongy
Myocardium

PRV+/Jaundice

Epicardium



Compact Myocardium



By the time a Chinook salmon becomes jaundice, heart inflammation has largely dissipated and PRV all but disappears from the heart

Spongy Myocardium

500 μ m

HEART

PRV (red) in RBCs (arrowheads) and cardiomyocytes, mostly in the spongy myocardium (arrows)




HEART

PRV (red) is initially present in the RBCs, but moving into the cardiomyocytes (mostly in the spongy myocardium), particularly in the VDD phase, and receding in the Jaundice phase

PRV+

PRV+/VDD

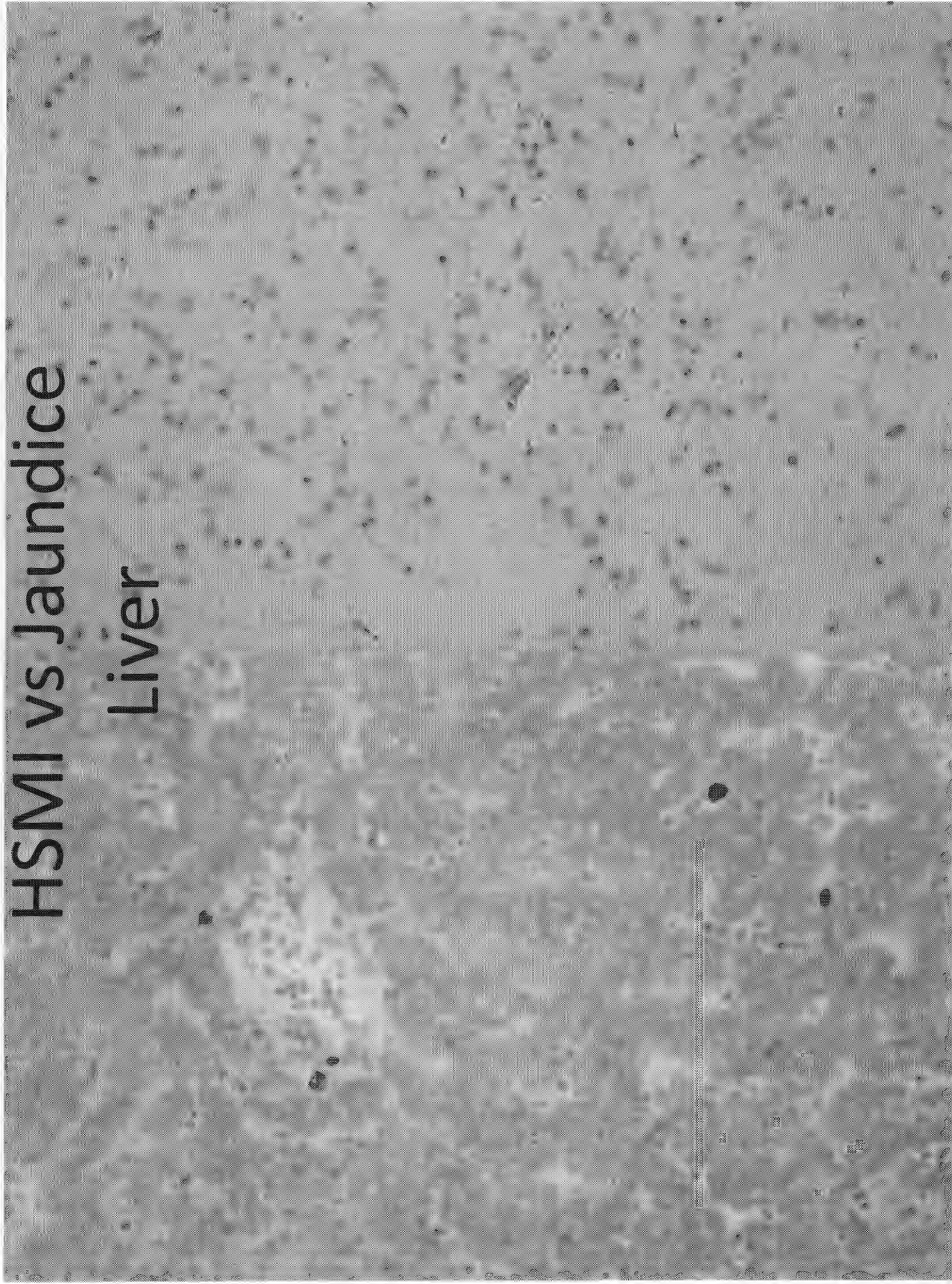
PRV+/Jaundice



Similarities and Differences Between HSMI (Atlantic salmon) and Jaundice (Chinook salmon)

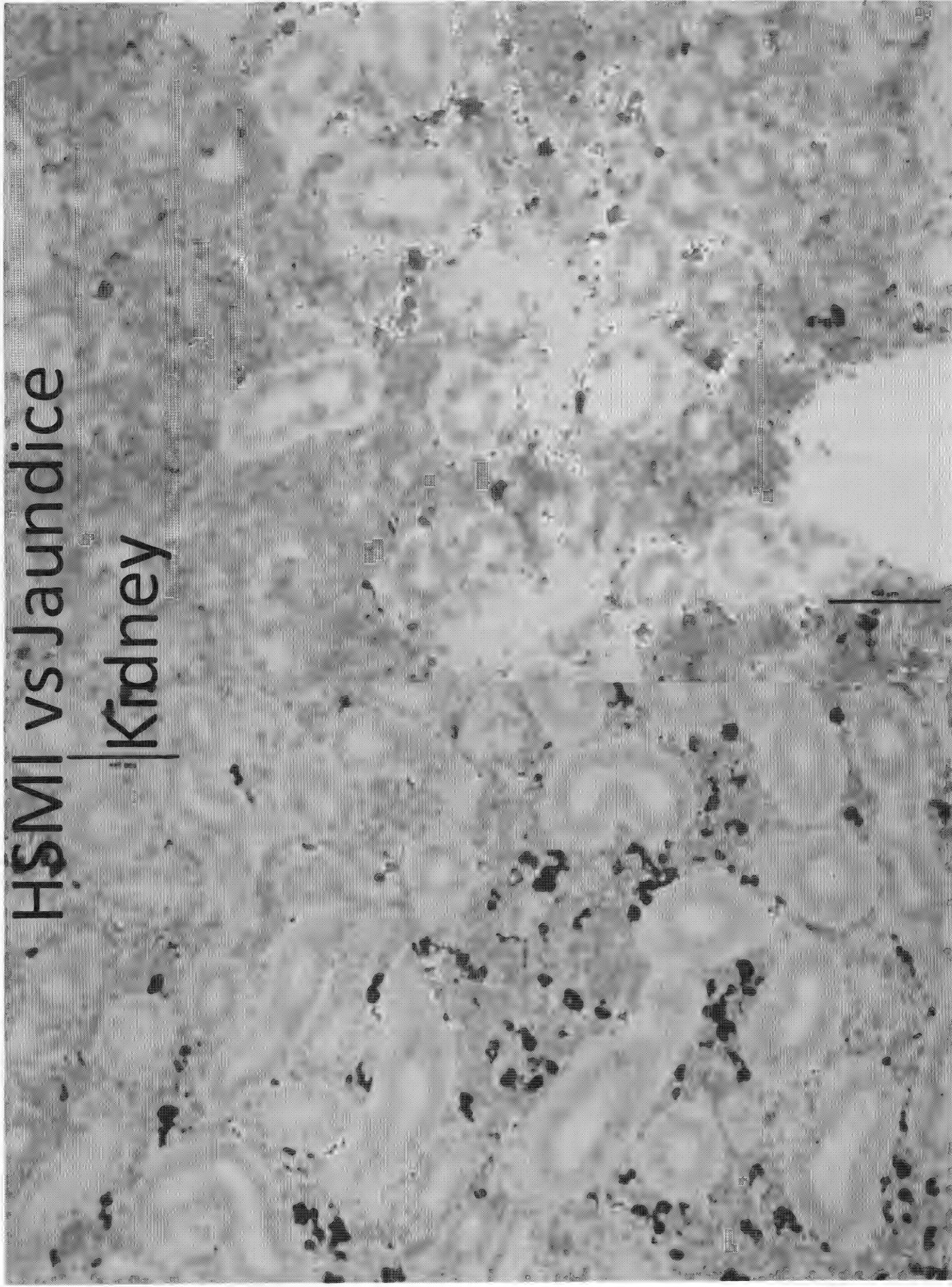
HSMI vs Jaundice

Liver



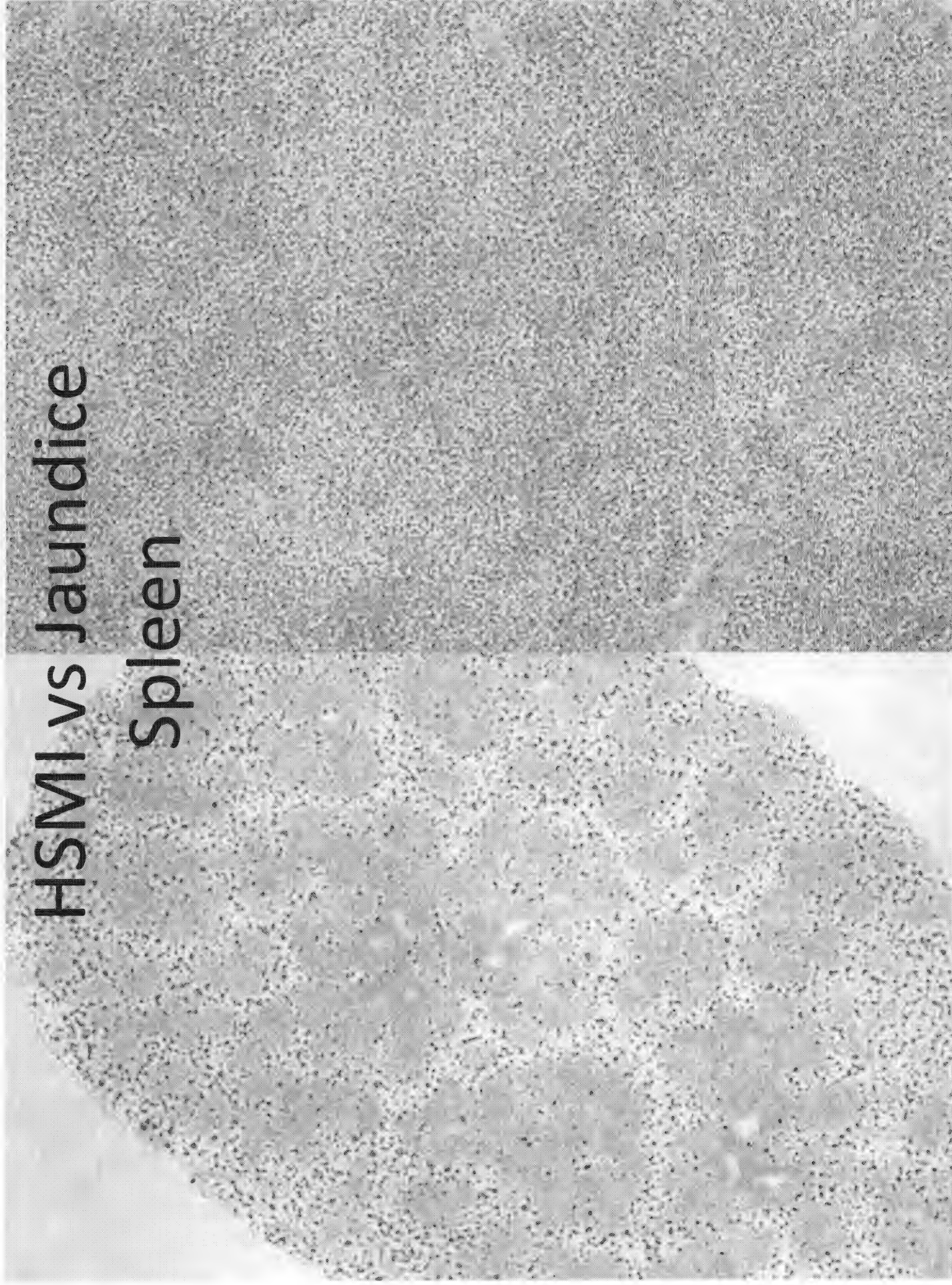
HSMI vs Jaundice

Kidney

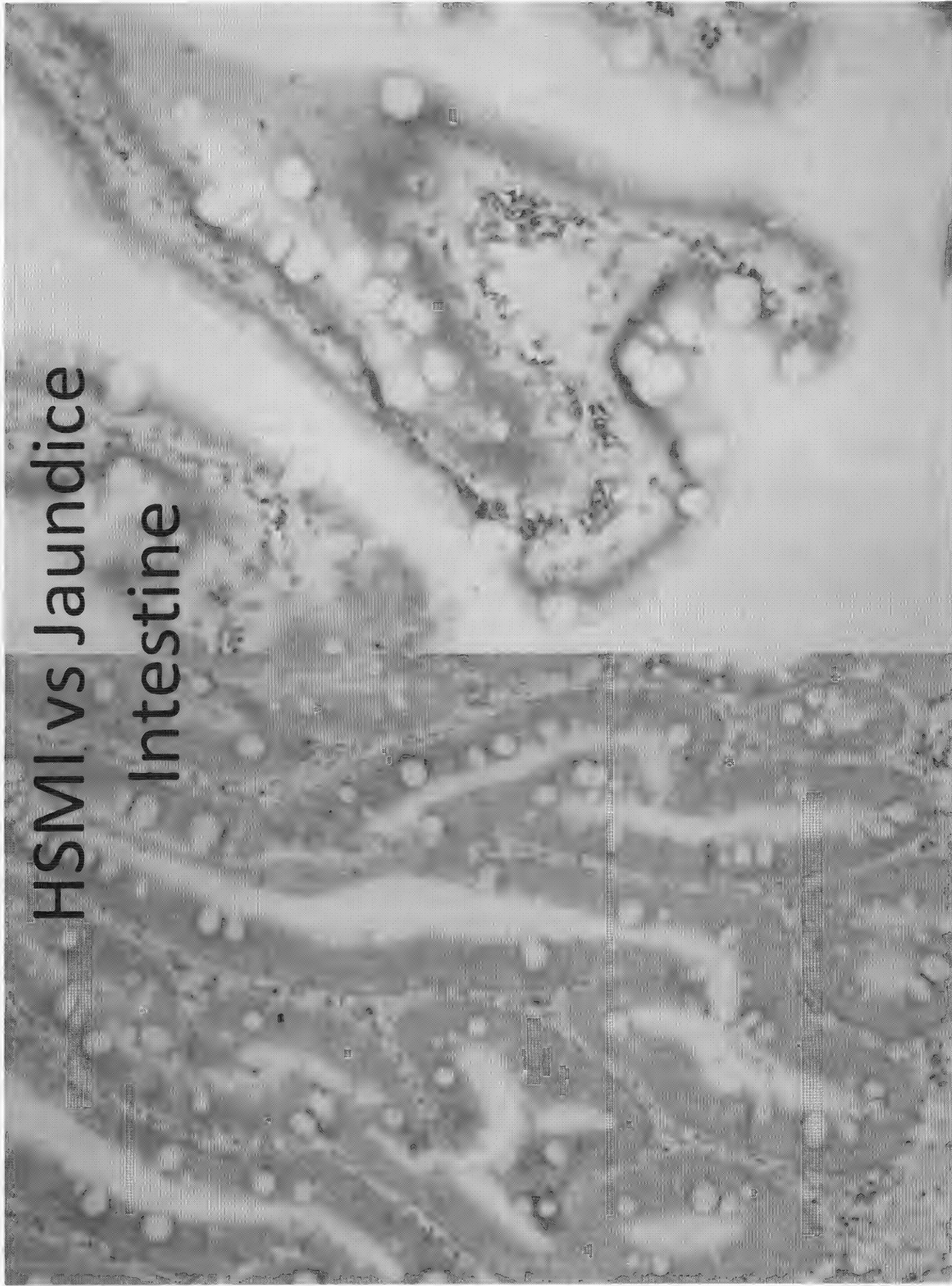


HSMI vs Jaundice

Spleen



HSMI vs Jaundice Intestine



HSMI vs VDD/Jaundice Heart

Summary – HSMI/Jaundice

PRV (-/+++) vs Lesions (0-3)

Atlantic salmon

	Liver	Kidney	Spleen	Heart	Intestine	Blood	Inflammation
PRV+/No Lesions	-	+	+	-	-	+++	
	0	0	0	0	0		
PRV+/Developing lesions	++	++	+++	++	+	++	
	0	1	2	1 to 2	0		
PRV+/HSMI	+	+	+++	+++	-	++	
	1	1	2	3	0		

Chinook salmon

	Liver	Kidney	Spleen	Heart	Intestine	Blood	Haemolysis/ Degeneration
PRV+	-	+	+	-	-	+++	
	0	1	0	0	0		
PRV+/VDD	+++	+++	+++	++	++	++	
	2	3	2	2	0		
PRV+/Jaundice	++	+++	+++	+	+	++	
	3	3	2	0 to 1	0		

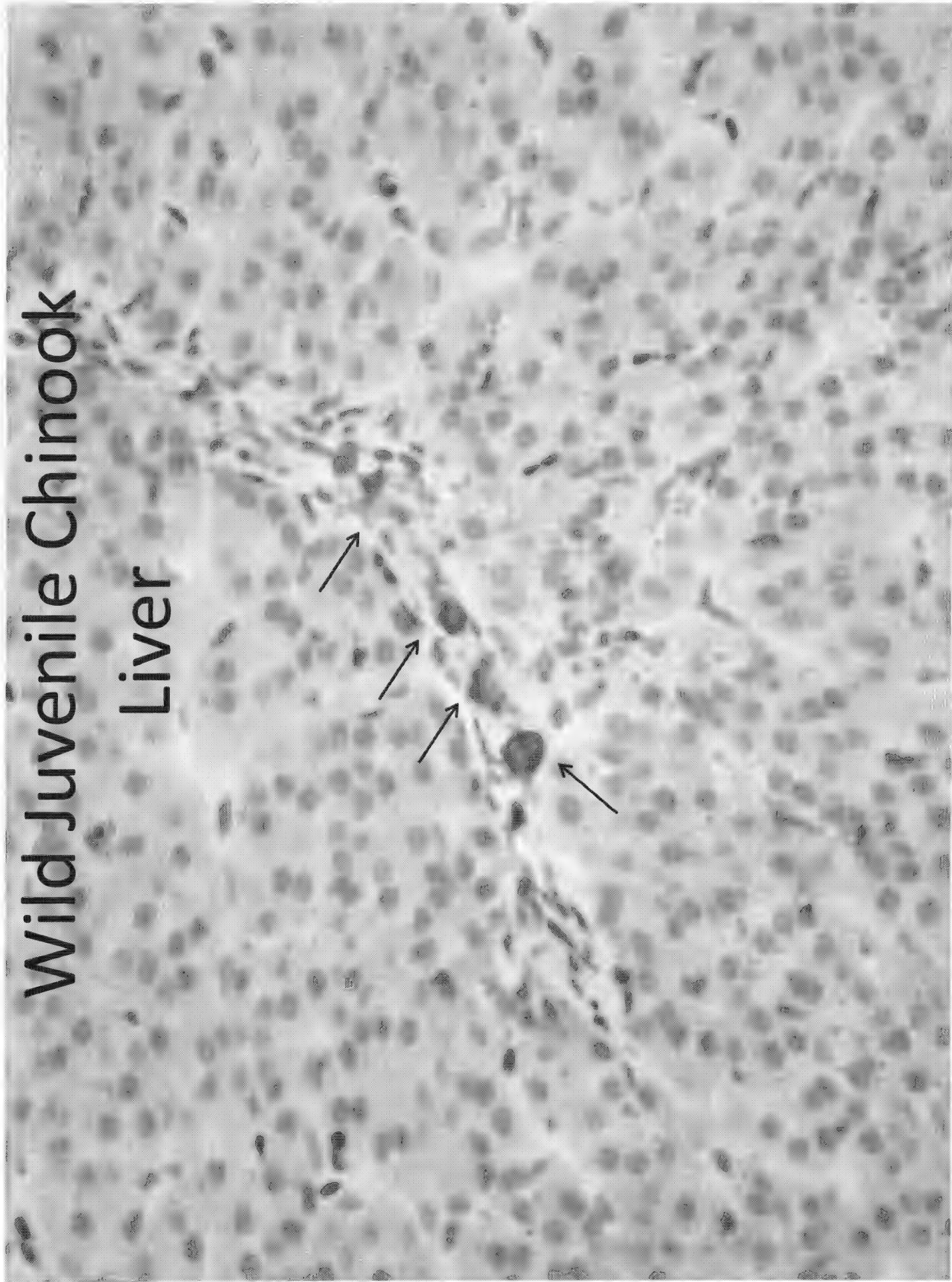


Wild Juvenile Chinook

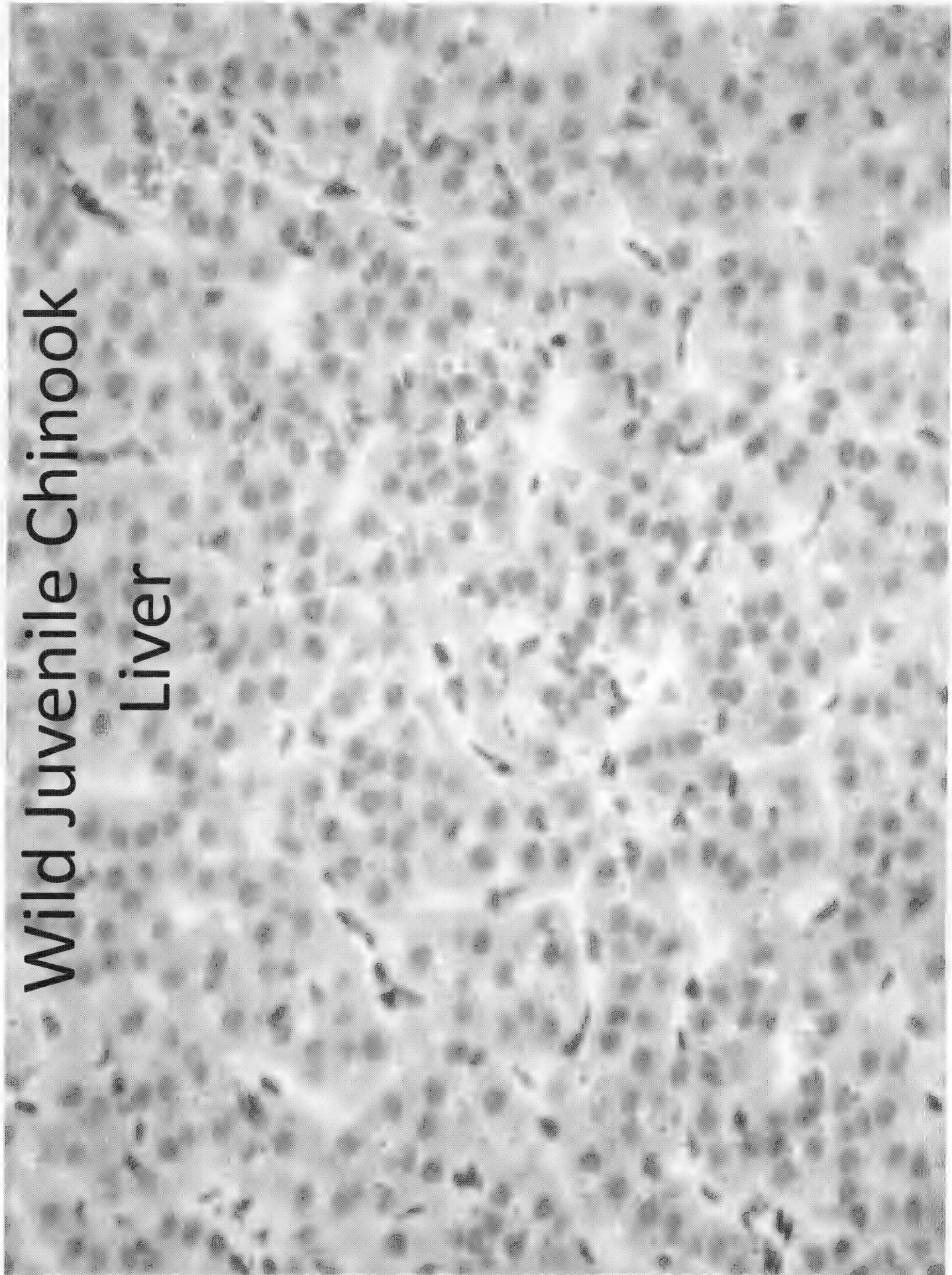
West Coast Vancouver Island

PRV+/VDD

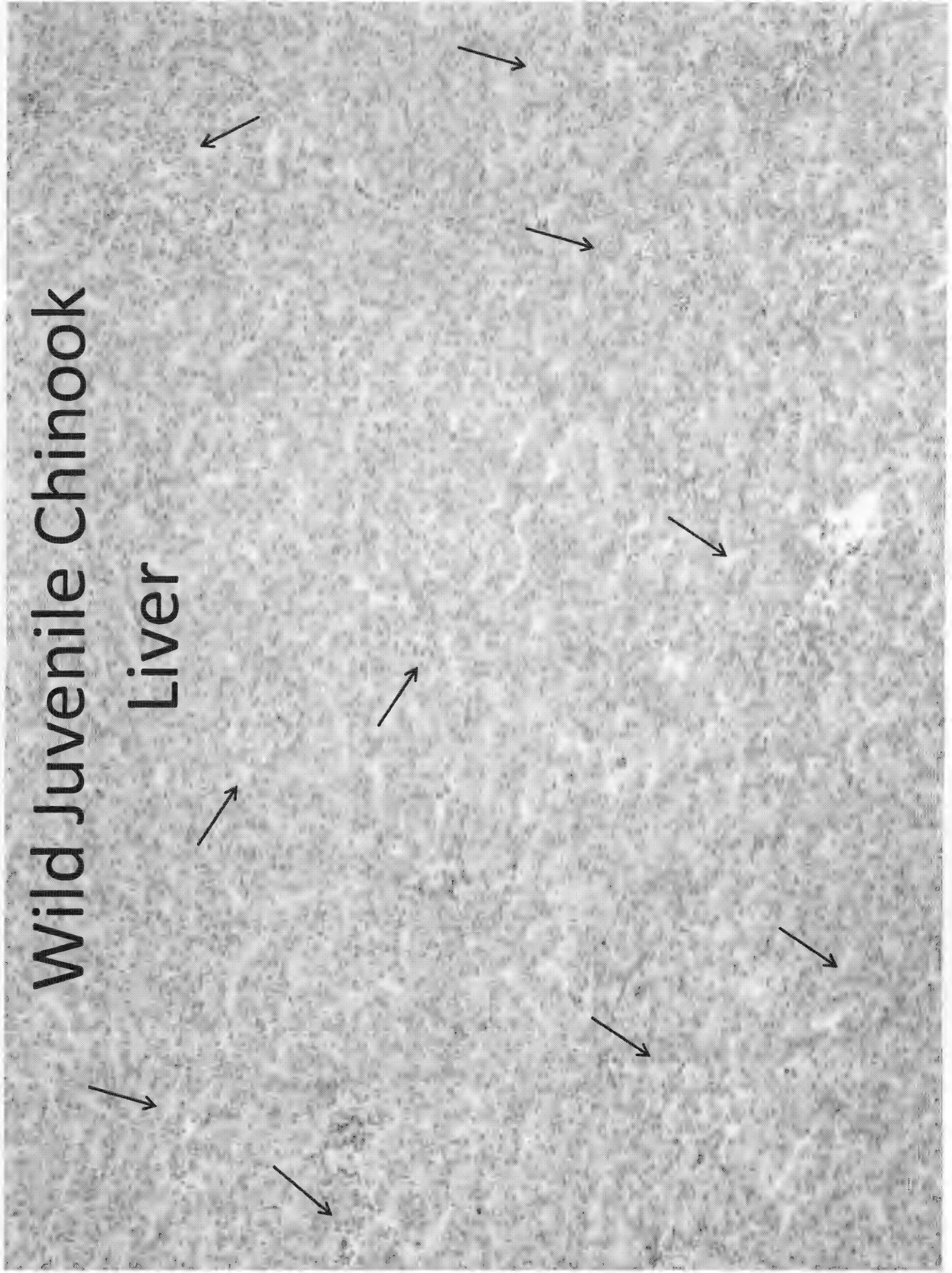
Wild Juvenile Chinook Liver



Wild Juvenile Chinook Liver



Wild Juvenile Chinook Liver



Wild Juvenile Chinook Liver

This wild Chinook would be comparable to a farmed Chinook VDD positive fish, with some evidence of liver necrosis in area surrounding abundant PRV

100 μ m

Wild Juvenile Chinook Posterior Kidney

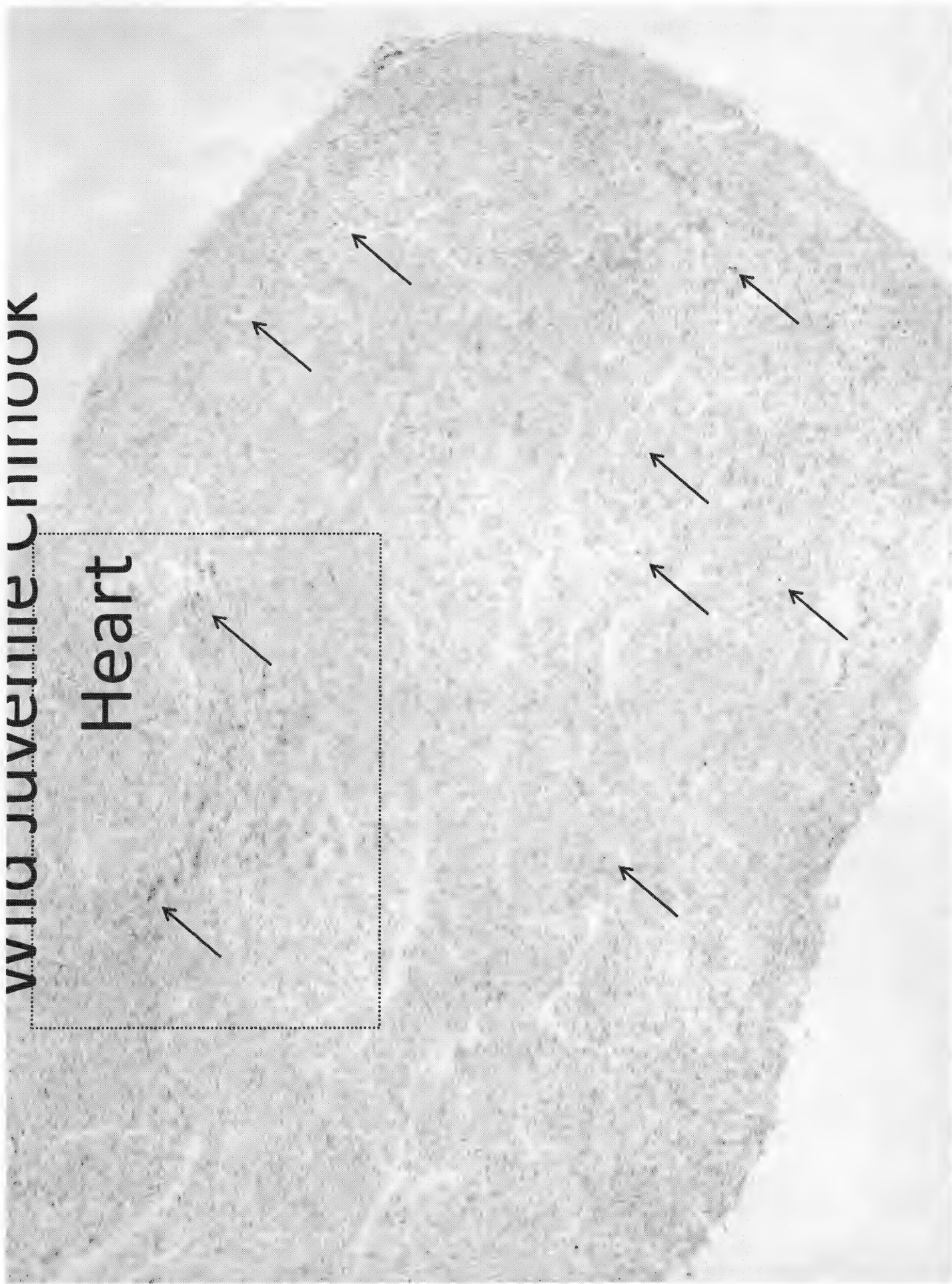
This wild Chinook would be comparable to a farmed Chinook VDD positive fish—but not yet fully necrotic in kidney

Wild Juvenile Chinook Spleen

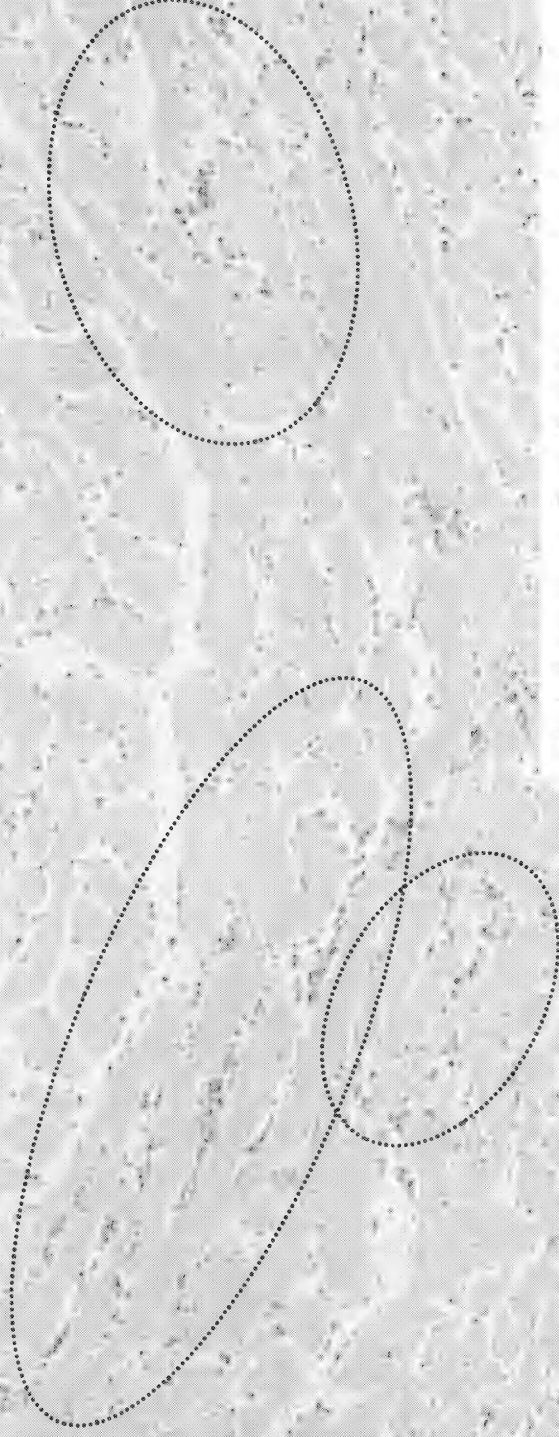
Brownish stain indicates massive RBC lysis, red indicates very large abundance of virus in spleen of wild Chinook salmon—similar to what we see in farmed Chinook

Wild juvenile Chinook

Heart

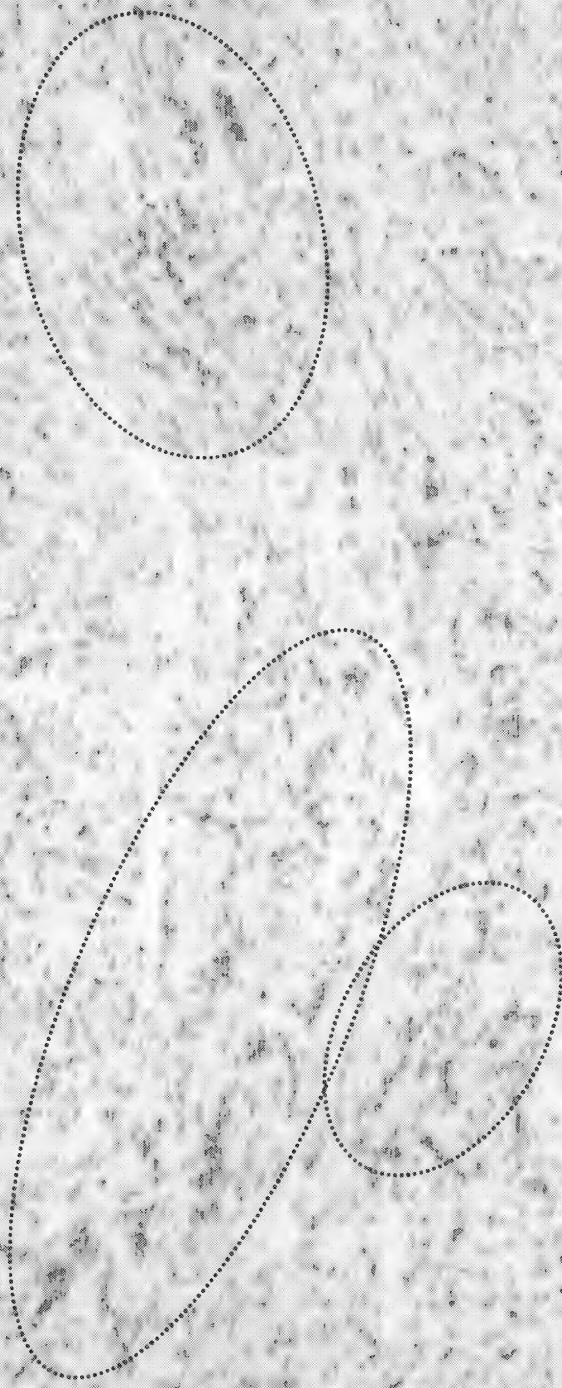


Wild Juvenile Chinook Heart



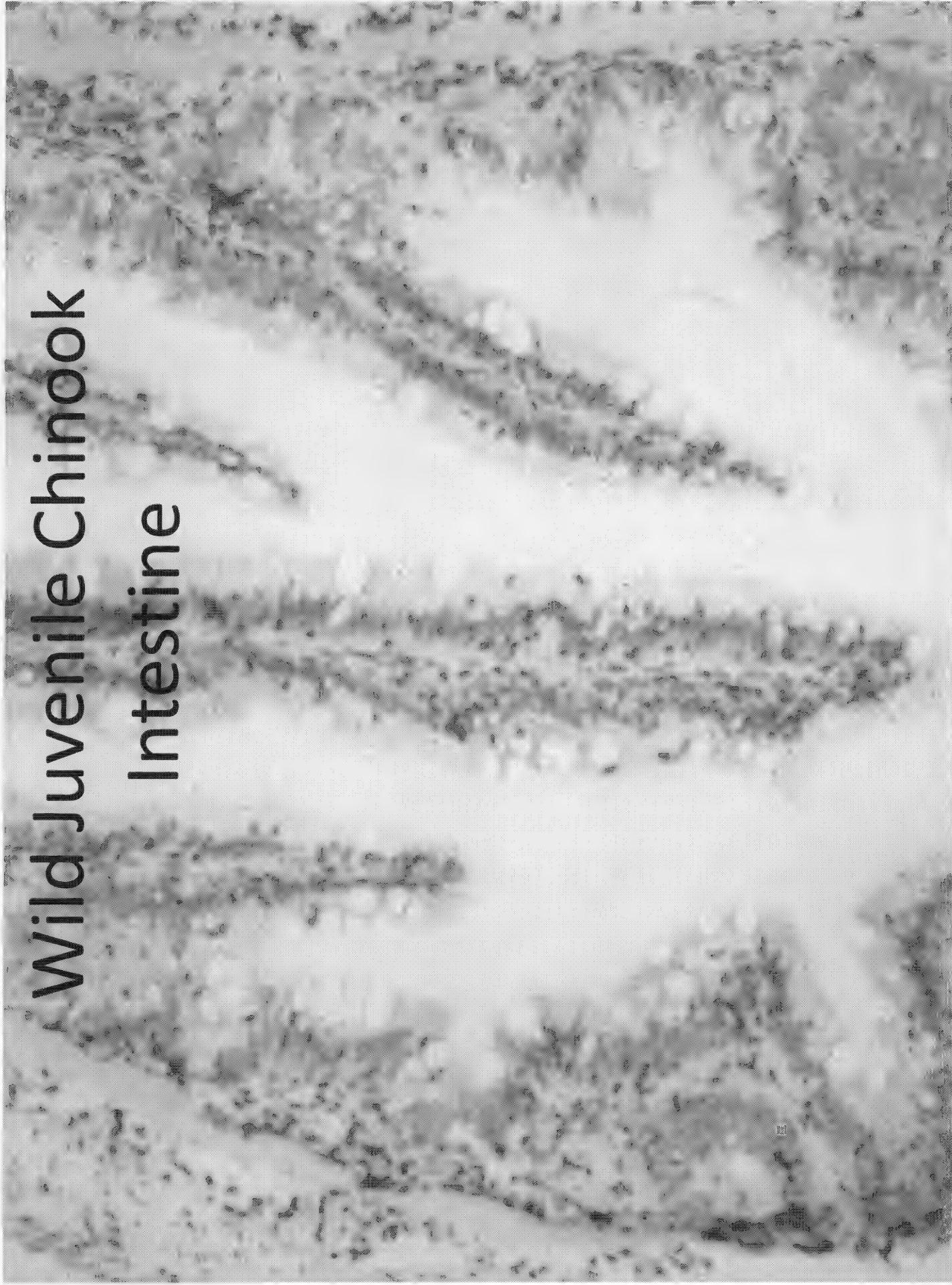
Evidence of mild heart lesions in PRV infected wild salmon indicate an infection equivalent to a VDD positive farmed Chinook salmon

Wild Juvenile Chinook Heart



PRV is infecting areas where heart inflammation is developing

Wild Juvenile Chinook Intestine





Conclusions

In BC, PRV-Ia is likely causative of diseases that manifest differently in Atlantic and Pacific salmon: HSML and Jaundice/Anemia

- HSML is an inflammatory disease affecting heart and skeletal muscle
- Jaundice/anemia is a necrotic disease primarily affecting the liver and kidney, but with transient inflammatory lesions in the heart
- In both diseases, PRV begins by infecting RBCs; there is no evidence of disease or VDD in fish while PRV is exclusively in the blood
- In both diseases, once the virus is released to infect other tissues, a host viral disease (VDD) is stimulated and pathological lesions may develop
- In HSML, the virus appears to be released without rupturing the red blood cells; in jaundice/anemia, mass lysis of RBCs is evidenced by anemia and hemosiderin, resulting in the release of hemoglobin in levels in excess of what can be processed by hepatocytes and kidney tubules
 - While there is evidence that PRV-Ia infects liver and kidney cells that become necrotic, it is not clear if they become necrotic due to hemoglobin toxicity or viral infection, but in either case, the virus is clearly involved



Conclusions

As in Norway, it is highly likely that PRV-related diseases are more prevalent than currently understood

- VDD panel identifies fish at early stages of disease development that are not currently classified as PRV-related diseases, but many contain lesions that are in the developmental pathway towards the full disease
- PRV may be playing a co-infection role in the manifestation of other diseases; many fish with high loads of PRV classifying as VDD are diagnosed non-viral diseases as the cause of death, but may also contain lesions associated with HSML or jaundice

Our evidence shows the same strain of PRV (Ia) has a role in diseases developing in both Atlantic and Chinook salmon, information that should be considered carefully when determining the level of risk that high concentrations of this virus in farmed salmon pose to wild salmon in BC.

While not yet demonstrating cause and effect (with jaundice), the localization of the virus in tissues clearly demonstrates the virus has a role in disease development in Chinook salmon

Miller-Saunders, Kristi

From: Miller-Saunders, Kristi
Sent: December-11-17 9:42 PM
To: Brian Riddell
Subject: RE: PRV In Situ Paper Outline.docx

Well if we removed the sequencing and vdd for sshi farmed fish we might be able to push it out faster. I will talk to my team.

From: Brian Riddell [briddell@PSF.CA]
Sent: December 11, 2017 9:14 PM
To: Miller-Saunders, Kristi
Subject: RE: PRV In Situ Paper Outline.docx

My only concern is the Provincial Panel will be delivered in the beginning of February and they will be looking for hard advice. If we can get a manuscript organized in that timeframe that would be great but then we will have to contend with the communication plan and approval within DFO.

From: Miller-Saunders, Kristi [mailto:Kristi.Saunders@dfo-mpo.gc.ca]
Sent: December 11, 2017 9:05 PM
To: Brian Riddell <briddell@PSF.CA>
Subject: FW: PRV In Situ Paper Outline.docx

In answer to your question, yes we have been talking. See outline above. It will take an extra month or so, but I would really like to see a comparative piece on HSMI and Jaundice, showing the in situ localization of the virus in both diseases. I think when you understand that really the key difference between the two diseases is really just the massive lysis of red blood cells in Jaundice versus trickling out of virus in HSMI, the fact that there can be two superficially differently appearing diseases in two species makes more sense and would provide more powerful evidence of a linkage between PRV and disease development.

Kristi

From: Miller-Saunders, Kristi
Sent: December 11, 2017 11:43 AM
To: DiCicco, Emiliano
Subject: PRV In Situ Paper Outline.docx

This would be my ideal paper, not just a note, but something definitive that would show that the SAME virus likely causes TWO related but different diseases in Atlantic and Pacific Salmon. We can discuss other options, but this could be very powerful. Ideally we would follow up with a paper collaborating with Chile, Norway, and Japan and doing in situ hybridization on their Pacific salmon species with PRV-related diseases using both our probe and probes designed to their strains... We should start contacting them with this possibility sooner rather than later. For our initial paper, it would be useful to at least get a sample from Norwegian RT to work with from Espen or Oystein so that we can co-publish with them if they are interested.

Kristi

Miller-Saunders, Kristi

From: Taylor, Nathan
Sent: December-13-17 6:02 AM
To: Miller-Saunders, Kristi
Subject: [REDACTED]

FYI

From: Townsend, Jill
Sent: Tuesday, December 12, 2017 4:40 PM
To: Taylor, Nathan
Subject: [REDACTED]

[REDACTED]

From: Taylor, Nathan
Sent: December-12-17 2:51 PM
To: Townsend, Jill
Subject: [REDACTED]

[REDACTED]

From: Townsend, Jill
Sent: Tuesday, December 05, 2017 3:51 PM
To: Taylor, Nathan
Cc: Lowe, Carmel
Subject: [REDACTED]

Thanks Nathan,

[REDACTED]

Jill

From: Taylor, Nathan
Sent: December-05-17 3:46 PM
To: Townsend, Jill
Cc: Lowe, Carmel
Subject: [REDACTED]

[REDACTED]

Best

Nathan

s.14(a)
s.19(1)
s.21(1)(a)
s.21(1)(b)
s.23

From: Townsend, Jill
Sent: Tuesday, December 05, 2017 12:03 PM
To: Taylor, Nathan
Cc: Lowe, Carmel
Subject: [REDACTED]

Hello Nathan,

[REDACTED]

Jill Townsend

Litigation Case Manager, Litigation Unit, Fisheries & Oceans Canada | Pêches et Océans Canada, Pacific Regional Office | Région du Pacifique, 200-401 Burrard Street | 401 rue Burrard, Pièce 200, Vancouver, BC V6C 3S4, Jill.Townsend@dfo-mpo.gc.ca Telephone | Téléphone (604) 658-2843, Cell | [REDACTED] Government of Canada | Gouvernement du Canada

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s.14(a)

s.16(2)(c)

From: Taylor, Nathan
Sent: December-05-17 9:13 AM
To: Townsend, Jill
Cc: Lowe, Carmel
Subject: [REDACTED]

s.19(1)

s.21(1)(a)

s.21(1)(b)

s.23

Hi Jill.

[REDACTED]

N.

[REDACTED]

Page 1784

**is withheld pursuant to sections
est retenue en vertu des articles**

14(a), 21(1)(b), 23, 21(1)(a)

**of the Access to Information Act
de la Loi sur l'accès à l'information**

Ryan, Patricia

From: Moore, Wayne
Sent: December-13-17 9:02 AM
To: Parsons, Jay
Subject: FW: Aquaculture testing

Categories: ATIP

fyi

From: McPherson, Arran
Sent: December 12, 2017 5:24 PM
To: Lowe, Carmel <Carmel.Lowe@dfo-mpo.gc.ca>; Moore, Wayne <Wayne.Moore@dfo-mpo.gc.ca>
Subject: FW: Aquaculture testing

FYI.

From: McPherson, Arran
Sent: Tuesday, December 12, 2017 5:24 PM
To: Blewett, Catherine <Catherine.Blewett@dfo-mpo.gc.ca>
Cc: Reid, Rebecca <Rebecca.Reid@dfo-mpo.gc.ca>; Hopkins, Lillian <Lillian.Hopkins@dfo-mpo.gc.ca>; White, Andrea <Andrea.White@dfo-mpo.gc.ca>
Subject: Aquaculture testing

Catherine, just a quick head's up that DFO Science is assisting ECCC/Province's efforts related to their investigations into recent effluent discharged at Tofino and Brown's Bay aquaculture sites.

DFO Science assisted in sample collection on Dec 4-6th and in response to a request, will be processing PRV testing this week. While this work is underway, it has been clarified that requests for advice from ECCC/province should go through the CSAS process to ensure the right experts are involved, peer review takes place (and for tracking purposes).

We will also be connecting with Province of BC to make them aware of this process as well. We will keep you advised on outcome of the results/release. I suggest this be shared with MINO for their info re our involvement.

Arran.

Dickie, Catherine

From: Lowe, Carmel
Sent: December 13, 2017 10:06 AM
To: Miller-Saunders, Kristi; Taylor, Nathan
Cc: MacDougall, Lesley
Subject: PRV testing

Both – thanks for letting me know your schedules. Lesley and I met and she is going to start populating a Rapid Science Response with the (minimal) information I have been able to provide to her. It will require your input for sure. It is not a particularly onerous template – just needs to capture what has been requested, by whom, for what. What we have done to respond and how. I am thinking we would simply attach the analytical results as an 'Annex' to the response.

Suggest we meet tomorrow afternoon to ensure we are all clear on whose doing what in what timeframes.... Etc.

Carmel

Carmel Lowe, Ph.D.
Regional Director Science | Directrice régionale des sciences
Fisheries and Oceans Canada | Pêches et Océans Canada
Pacific Biological Station | Station biologique du Pacifique
3190 Hammond Bay Rd, Nanaimo, BC, Canada V9T 6N7

Carmel.Lowe@dfo-mpo.gc.ca
Telephone | Téléphone 250-756-7177
Facsimile | Télécopieur 250-729-8360
Government of Canada | Gouvernement du Canada

Miller-Saunders, Kristi

From: Lowe, Carmel
Sent: December-13-17 5:14 PM
To: MacDougall, Lesley; Miller-Saunders, Kristi; Taylor, Nathan
Subject: RE: PRV Sampling

Thanks Lesley. I expect Kristi and Nathan will help with completing/revising the draft – but would like to get an understanding of when they might be available to do so as I further understand that the testing will be completed tomorrow sometime ?

Just so everyone is clear on the process the information will be transmitted to clients once the Rapid Science Response is approved. I am in Vancouver for meetings in am but will be back in the office in the aft and happy to review then.

Carmel

Carmel Lowe, Ph.D.
Regional Director Science | Directrice régionale des sciences
Fisheries and Oceans Canada | Pêches et Océans Canada
Pacific Biological Station | Station biologique du Pacifique
3190 Hammond Bay Rd, Nanaimo, BC, Canada V9T 6N7

Carmel.Lowe@dfo-mpo.gc.ca
Telephone | Téléphone 250-756-7177
Facsimile | Télécopieur 250-729-8360
Government of Canada | Gouvernement du Canada

From: MacDougall, Lesley
Sent: Wednesday, December 13, 2017 2:09 PM
To: Miller-Saunders, Kristi <Kristi.Saunders@dfo-mpo.gc.ca>; Lowe, Carmel <Carmel.Lowe@dfo-mpo.gc.ca>
Cc: Taylor, Nathan <Nathan.Taylor@dfo-mpo.gc.ca>
Subject: RE: PRV Sampling

Hello all;

I've attached a draft Rapid Science Response, with the preliminary information I've received, as a start to ensure that the results and information resulting from this request can be documented.

As noted – definitely draft, needs input from ADGT

From: Miller-Saunders, Kristi
Sent: 2017–December-12 1:24 PM
To: Lowe, Carmel
Cc: Taylor, Nathan; MacDougall, Lesley
Subject: RE: PRV Sampling

This request came to me on a Thursday afternoon, [REDACTED] and while I would normally have informed Nathan, he was away. I was not aware of any process involving Lesley MacDougall. They had approached a number of diagnostic labs already, and none of them had experience with water samples. My lab does. Hence, by the time they came to me, they were quite desperate as they had planned on collecting the samples the following Monday-Tuesday and needed to know how they would do this. I involved Curtis Suttle's lab in this conversation as he is a marine virologist with vast experience in isolating viruses from the ocean, and is working with us on this end in the SSHI. There

s.19(1)

was no way I would have had time to fill out extensive paperwork on this [REDACTED] so I suggested we go ahead and collect the samples, with my technician Amy Tabata's involvement, to ensure they were collected in a way that was useful, and that we had to leave the rest until I returned.

I now know that there is a process and will inform the three of you if any requests of this nature arise in future. I will ask them the question you pose below and let you know how they respond.

Kristi

From: Lowe, Carmel
Sent: December-12-17 12:57 PM
To: Miller-Saunders, Kristi
Cc: Taylor, Nathan; MacDougall, Lesley
Subject: RE: PRV Sampling

Kristi,

Thanks for sharing this with me. I have to say I am a bit concerned at how these requests for sampling and analyses from the province-ECCC were routed directly to you given that our department has formalized approaches/policies for requesting/providing science information and advice to clients. To ensure we are complying with the policies, I would ask that any further requests you receive be directed to Lesley MacDougall in our CSAS office (this should certainly be done for the analyses that are being run now in your lab). Lesley has overall responsibility for managing client requests, including, tracking and reporting, securing review and approval as appropriate and transmitting results to the clients. In case you were not aware, CSAS has also recently developed tools to support the provision of information/advice required under very short timeframes which I suspect may be the case with the requests you have received? Certainly understanding how they propose to use the results in their aquaculture review or otherwise will be important for us to document/understand as would knowing if we can anticipate any additional requests for support in near future. To this end, I would appreciate you getting in touch with your contacts to clarify these elements soonest and sharing the outcome of those discussions with Lesley, Nathan and I. If they do intend using the information-advice you provide in their review then a copy of their TOR for this review would be very helpful.

Carmel

Carmel Lowe, Ph.D.
Regional Director Science | Directrice régionale des sciences
Fisheries and Oceans Canada | Pêches et Océans Canada
Pacific Biological Station | Station biologique du Pacifique
3190 Hammond Bay Rd, Nanaimo, BC, Canada V9T 6N7

Carmel.Lowe@dfo-mpo.gc.ca
Telephone | Téléphone 250-756-7177
Facsimile | Télécopieur 250-729-8360
Government of Canada | Gouvernement du Canada

From: Miller-Saunders, Kristi
Sent: Monday, December 11, 2017 9:10 PM
To: Lowe, Carmel <Carmel.Lowe@dfo-mpo.gc.ca>
Subject: FW: PRV Sampling

Here is what I sent to the BC Ministry of the Environment. Before we release the PRV testing results, I will have a conversation with them about how they might use this information in their aquaculture review and whether DFO can be of any further assistance, as requested.

s.19(1)

Kristi

From: Miller-Saunders, Kristi
Sent: December 11, 2017 8:47 PM
To: Austin, Joyce ENV:EX; Tabata, Amy; Tesch, David ENV:EX; 'Russell, Ken (EC)'
Cc: Hunse, Laura A ENV:EX; McRae, Jake (EC)
Subject: RE: PRV Sampling

Joyce,

Enclosed is the talk I gave at a BC Salmon Farmers Association meeting on PRV-HSMI state of knowledge workshop December 4th- 5th attended by Norwegian scientists, industry vets and leaders, BC and US Scientists, and DFO regulators. The talk outlines the most recent research out of my lab on PRV and linkages with disease in Pacific salmon. I apologize that it is long and pretty scientific, but the key points are:

We have demonstrated that PRV infections in Chinook salmon can induce a host response that we have shown previously to be diagnostic of the presence of viral disease. This work was published in Conservation Physiology this year.

We demonstrate that 14% of moribund/dead farmed Chinook salmon on the west coast obtained through the DFO audit program were diagnosed with jaundice/anemia, a disease that around the world has been associated with various strains of PRV. There is only a single strain of PRV in BC, that which is known to cause HSMI in Atlantic salmon. We published on HSMI in BC farmed Atlantic salmon in Feb. 2017 in PlosOne.

We show that throughout the developmental pathway of jaundice and across multiple affected tissues, PRV is localized within the regions and cells that become diseased, whether disease is through cell death (necrosis) in liver and kidney or inflammation in heart. We gave a similar talk on HSMI in Atlantic salmon and also demonstrated PRV localized with inflammatory lesions in heart and skeletal muscle tissue.

The primary infective tissue for PRV in both species is the red blood cells (which is why blood water from farmed fish is potentially a strong risk for PRV transmission to wild fish). We show that while PRV remains exclusively in the blood, even at high levels, it is tolerated and there is no disease response in the host. When the virus leaves the blood cells to infect other tissues/cells, it induces a disease response in the host.

The difference between HSMI in Atlantic salmon and jaundice/anemia in Chinook salmon is that in HSMI, PRV appears to leave the red blood cells without lysing (rupturing) them, whereas in Chinook salmon, there is massive lysis of red blood cells leading to anemia (pale gills and tissues) and overloading the kidney and liver with Heme from the breakdown of hemoglobin. Heme is processed in kidney and liver, but becomes toxic at high levels, leading to necrosis (death) of kidney tubules and hematocytes (liver cells), and a jaundice (yellowing) appearance in the fish. While we show that the virus also directly infects these cells, we suspect the heme overload, caused by PRV lysis of red blood cells, is likely the main mechanism leading to disease in jaundice fish. Liver and kidney are not highly affected in HSMI in Atlantic salmon, as the virus goes on to infect muscle cells (heart and skeletal) causing inflammation. This inflammatory response is present, but much reduced in Chinook salmon with jaundice.

We have also demonstrated early (jaundice) disease development in wild Chinook salmon. There was a presentation by Dr. Maureen Purcell at the same meeting that showed an association of the same strain of PRV with a similar disease, which they and the Japanese call EIBS, in Washington State Coho salmon.

I hope this helps in your consideration of the potential for risk in the release of blood water. I am happy to discuss these results directly if there is any need for clarification. We are working up a publication on these data at present.

Kristi Miller-Saunders
Head, Molecular Genetics
Pacific Biological Station

From: Austin, Joyce ENV:EX [Joyce.Austin@gov.bc.ca]
Sent: December 11, 2017 10:58 AM

To: Tabata, Amy; Tesch, David ENV:EX; 'Russell, Ken (EC)'
Cc: Hunse, Laura A ENV:EX; McRae, Jake (EC); Miller-Saunders, Kristi
Subject: RE: PRV Sampling

Hi Amy,

I have already contacted Kristi Miller and I'm waiting on her to give me a call back,

Thanks

Joyce Austin, Ph.D.

Senior Provincial Laboratory Specialist (Unit Head)
Environmental Monitoring, Reporting & Economics
Knowledge Management Branch | Ministry of Environment & Climate Change Strategy
Mailing address : PO Box 9347 STN PROV GOVT, Victoria, BC V8W 9M1
Physical address : 525 Superior St, Victoria, BC V8V 1T7
Tel.: 778-698-4434;
Cel.: [REDACTED]
Fax: 250-356-7197

From: Tabata, Amy [<mailto:Amy.Tabata@dfo-mpo.gc.ca>]
Sent: Monday, December 11, 2017 10:55 AM
To: Tesch, David ENV:EX; 'Russell, Ken (EC)'
Cc: Austin, Joyce ENV:EX; Hunse, Laura A ENV:EX; McRae, Jake (EC); Miller-Saunders, Kristi
Subject: RE: PRV Sampling

We are currently processing the samples, and expect results in the next few days.

Please contact

Dr Kristi Miller – Head – Molecular Genetics Lab, cc'd above or by phone at 250-756-7155

Thanks

Amy Tabata

Molecular Genetics Technician
Fisheries and Oceans, Canada
Pacific Biological Station
3190 Hammond Bay Road
Nanaimo, B.C. V9T 6N7
ph. 250-756-3369
fax 250-756-7031
email amy.tabata@dfo-mpo.gc.ca

From: Tesch, David ENV:EX [<mailto:David.Tesch@gov.bc.ca>]
Sent: December-11-17 10:35 AM
To: 'Russell, Ken (EC)'
Cc: Austin, Joyce ENV:EX; Hunse, Laura A ENV:EX; Tabata, Amy; McRae, Jake (EC)
Subject: RE: PRV Sampling

Thanks Ken,

s.16(2)(c)

I've been able to get a hold of Joyce and she is going to give DFO a call.

Regards,
D.

From: Russell, Ken (EC) [<mailto:ken.russell@canada.ca>]
Sent: Monday, December 11, 2017 10:29 AM
To: Tesch, David ENV:EX
Cc: Austin, Joyce ENV:EX; Hunse, Laura A ENV:EX; Tabata, Amy (Amy.Tabata@dfo-mpo.gc.ca); McRae, Jake (EC)
Subject: RE: PRV Sampling

Good morning David,

I am not sure of the analysis time line for the PRV. Your best contact at this point in time would be Laura Hunse – who is in contact with Amy Tabata. Ms. Tabata is the DFO molecular geneticist technician who accompanied us during the sampling. I have CCed Ms. Hunse and Ms. Tabata on this Email.

I hope this helps

Ken Russell
Senior Enforcement Officer – Enforcement Branch
Environment and Climate Change Canada / Government of Canada
ken.russell@canada.ca / Tel : 250 756 7251 / Cell : [REDACTED]

Ken Russell,
Agent d'application de la loi Supérieur, Direction générale de l'application de la loi
Environnement et Changement Climatique / Gouvernement du Canada
ken.russell@canada.ca / Tel. : 250 756 7251 / Tel. Cell : [REDACTED]

From: Tesch, David ENV:EX [<mailto:David.Tesch@gov.bc.ca>]
Sent: December 11, 2017 9:12 AM
To: Russell, Ken (EC)
Cc: Austin, Joyce ENV:EX
Subject: PRV Sampling
Importance: High

Hi Ken,

My name is David Tesch and I am Joyce's Executive Director. Joyce is not in the office today and my DM is asking if there is an ETA on the results from the PRV sampling that was done at the fish farms early last week. Are you able to provide me an answer?

Regards,
David Tesch
Executive Director
Knowledge Management Branch
Ministry of Environment & Climate Change Strategy
778-698-4406
David.Tesch@gov.bc.ca

s.16(2)(c)

Miller-Saunders, Kristi

From: Miller-Saunders, Kristi
Sent: December-14-17 9:47 AM
To: MacDougall, Lesley; Lowe, Carmel
Cc: Taylor, Nathan
Subject: RE: Testing fish process effluent

These look good.
Kristi

From: MacDougall, Lesley
Sent: December 14, 2017 9:33 AM
To: Lowe, Carmel
Cc: Taylor, Nathan; Miller-Saunders, Kristi
Subject: RE: Testing fish process effluent

Hi Carmel; I've provided short answers to the questions posed by DFO Comms below, based on emails and my conversation with Amy yesterday - ADGT folks should probably edit for clarity / accuracy.

- How did we come to be involved in the testing?

BC Ministry of Environment & Climate Change Strategies (ENV), has an upcoming compliance audit for two fish processing plants that are currently the focus of investigation. DFO was contacted by ENV to assist with on-site sample collection, and to provide lab analysis of the samples. Other labs available at the time did not have experience with diagnostics from water samples.

- Are we working with partners, if so, who?

There is no formal partnership; however, Dr. Curtis Suttle's lab is aware of the lab analyses DFO is currently undertaking. Dr. Suttle is a marine virologist with experience in isolating viruses from marine water samples, and has collaborated with DFO scientists on other marine virology research.

- What lab are we using?

The DFO Forensics laboratory, at the Pacific Biological Station in Nanaimo BC, is being used to conduct the sample analyses. The DFO Forensics laboratory is a secure, restricted-access and restricted-use laboratory, where strict protocols are followed to ensure sample integrity.

- What pathogens/diseases are we testing for?

DFO has been asked to analyze effluent samples collected from two fish processing plants on December 4 and 5, 2017, for the presence or absence of the Piscine Reovirus (PRV).

- When will results be in?

Results will be in by the end of the week (Dec 15)

- What will happen if results show reason for concern / next steps?

Results will be considered in the context of background PRV levels. Further steps may include providing recommendations for marine effluent discharge viral load levels, and potential management and mitigation measures that can reduce risk to the environment (including, for example, recommended effluent treatment options, or proxy testing parameters). These recommendations may be used to guide policy, compliance and enforcement measures.

Dickie, Catherine

From: MacDougall, Lesley
Sent: December 14, 2017 11:03 AM
To: Miller-Saunders, Kristi; Taylor, Nathan; Lowe, Carmel
Subject: revised RSR for review prior to discussion today
Attachments: RSR2017_AQU01_Browns and TofinoPRV (2).docx

Hello all;

Based on emails, discussion with Amy, and the SR we completed on PRV a couple years ago, I've tried to flesh out the request, the process, and the context in advance of receiving the results. All of this will require further edits and input from ADGT staff.

L

Lesley MacDougall BSc, MMM, RPBio

Science Coordinator | Gestionnaire scientifiques

Centre for Science Advice | Centre des avis scientifiques

Pacific Region | Région du Pacifique

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PHONE #: 250-756-7088

lesley.macdougall@dfo-mpo.gc.ca

Centre for Science Advice Pacific

FPP non-CSAS Request for Rapid Science Response

REQUEST INFORMATION

Request Contact:	<i>Shirley Brown</i>	Project Type: Aquaculture-Emergency response
Date of request:	<i>December 11, 2017</i>	Project footprint:
Region of proposed impact:	Tofino and Browns Bay, British Columbia	Habitat Type: Coastal
Purpose of request:	Information for Ministry of Environment / Environment and Climate Change Canada investigation	
Potential affected species:	Pacific salmon	
Date required:	<i>December 18, 2017</i>	Request #:2017AQU01
Timeline rationale:		

PROJECT OVERVIEW

As a function of normally-operating fish processing plants, fish waste effluent is released back into the marine ecosystem.

BC Ministry of Environment & Climate Change Strategies (ENV) has an upcoming compliance audit for two fish processing plants that are currently the focus of investigation. The Browns Bay and Tofino fish processing plants have been subjects of recent public and media attention since a video showing fish waste effluent being released into the marine environment was circulated publicly.

DFO was contacted by ENV to assist with on-site sample collection, and to provide lab analysis of the samples. Other labs available at the time did not have experience with diagnostics from water samples.

1ST QUESTION

Context:

The BC Ministry of Environment & Climate Change Strategies (ENV), Environmental Protection Regional Operations Branch to requested assistance from DFO to advise on appropriate sampling collection methodology, and to test collected effluent for the presence of the Piscine Reovirus (PRV). At the Browns Bay site, effluent was collected from one source – at the plant itself, immediately prior to discharge out of the facility into the environment. At the Tofino site, effluent was collected from two sources; 1) from the fish harvest vessel and 2) from the plant, immediately prior to discharge out of the facility into the environment.

Objective/Question:

Specifically, ENV is requesting DFO provide advice/expertise to:

- Analyze effluent samples collected from two fish processing plants on December 4 and 5, 2017. EPD may require further effluent analyses as part of an upcoming compliance audit of fish processing plants in B.C.
- Assess the PVR data results of presence/absence and if present, to determine whether to test for live virus infectivity. From the information and scientific literature you provided, we understand that virus presence in effluent to the marine environment is a risk to wild salmon.
- Provide recommendations for marine effluent discharge viral load levels; if the virus levels are a problem, what can be done to minimize impacts and protect the environment. What kind of effluent treatment is recommended for marine discharges? Are there proxy parameters to test?
- Provide information to guide provincial government policy with respect to public health and safety as well as protection of the environment, which could include compliance and enforcement.

Importance:☒ Essential☐ Important☐ Desirable**SCIENCE RESPONSE****Response:**

Results from the PCR testing will confirm whether the fish being processed at each of the facilities at that time were infected with PRV; the results will not be able to provide advice regarding the load concentration.

Using the DFO Forensics laboratory, Polymerase Chain Reaction (PCR) testing of the effluent samples from Brown's Bay and Tofino was conducted, to test for the presence of PRV.

Piscine reovirus (PRV) is a non-enveloped, double stranded RNA virus, which is a member of the family Reoviridae (Palacios et al. 2010; Kibenge et al. 2013). PRV was first recognized in Norway, and has since been detected in salmonid and non-salmonid fish in the United Kingdom, Ireland, Denmark, Chile, the United States, and Canada. PRV occurs in populations of wild and farmed salmonids in British Columbia and in wild salmonids in US waters (Alaska and Washington State). However, information with respect to spatial and temporal occurrence of PRV in wild and farmed salmon populations and non-salmonid finfish is limited. This includes knowledge of prevalence of PRV in hatchery stocks in British Columbia. The ubiquitous nature of Piscine Reovirus (PRV), its apparent long time presence in wild Pacific salmonid stocks, and the lack of clear association with disease in laboratory challenge trials, suggest a low likelihood that the presence of this virus in any life stage of farmed Atlantic and Pacific Salmon would have a significant impact on wild Pacific Salmon populations.

While there is general scientific agreement that PRV is typically found in association with Heart and Skeletal Muscle Inflammation (HSMI), understanding the role of PRV in the development of HSMI has been complicated by a lack of culture techniques for this virus. Currently, there is no evidence from laboratory studies in British Columbia and Washington State that PRV infection is associated any disease state, including HSMI. HSMI has not been reported on BC salmon farms.

HSMI was first described and identified as an infectious disease by Kongtorp et al. (Kongtorp et al. 2004; Kongtorp, Taksdal, and Lyngoy 2004). Although several types of viral particles were visualized in HSMI lesions by electron microscopy and a viral etiology was suspected, it was not until 2010 that PRV was identified to be associated with HSMI and a molecular diagnostic test for PRV developed (Palacios et al. 2010; Watanabe et al. 2006). HSMI is one of several diseases that affect the heart and in moderate to severe cases the skeletal muscle of Atlantic Salmon (Biering and Garseth 2012; Kongtorp, Taksdal, and Lyngoy 2004). HSMI cannot be definitively diagnosed by histopathology, unless the affected fish on the farm also have clinical signs consistent with HSMI. Histopathology is used to confirm the diagnosis of HSMI.

PRV is also found in a high proportion of clinically healthy, wild and farmed Atlantic Salmon collected from fresh and saltwater in Norway (Palacios et al. 2010; Lovoll et al. 2010; Garseth et al. 2013). In some instances, PRV loads in wild Atlantic Salmon spawners lacking HSMI were higher than those reported from farmed Atlantic Salmon with HSMI, suggesting that factors other than high PRV loads may be required for HSMI development in the farmed fish (Garseth et al. 2013) (see also the 2014 downloadable report available at the Norwegian Veterinary Institute, Fish Health Reports). The range of PRV loads in farmed fish with HSMI often overlap with those in fish without HSMI, and PRV occurred at similar loads in cohorts of pre-smolts that remained disease free, as compared to cohorts that developed HSMI (Lovoll et al. 2012).

The DFO Forensics laboratory is a limited-access, restricted-use, secure lab where strict protocols are followed to ensure....

...no other samples are processed in the DFO forensics laboratory when a secure sample is being tested....

Results from the PCR testing conclude that...

Browns Bay – processing facility discharge

Tofino – vessel discharge

Tofino – processing facility discharge

Responder: XXXX, Science

Responder: _____

REVIEW INFORMATION

This response does not constitute delivery of peer – reviewed Science advice; it is intended as a rapid response to an immediate requirement for Science input.

Reviewed by: Lesley MacDougall, Coordinator, Centre for Science Advice Pacific Region

Date: XXXX, 2017

Comments: _____

Approved by: _____

Date: _____

Comments: _____

Ryan, Patricia

From: Moore, Wayne
Sent: December-14-17 5:16 PM
To: Parsons, Jay
Subject: Re: PRV Sampling

Categories: ATIP

Ok

Sent from my BlackBerry 10 smartphone on the Rogers network.

Original Message

From: Parsons, Jay
Sent: Thursday, December 14, 2017 5:13 PM
To: Moore, Wayne
Subject: Re: PRV Sampling

We are working on it and will be able to get it to you later tonight.

----- Original Message -----

From: Moore, Wayne
Sent: Thursday, December 14, 2017 02:06 PM
To: Parsons, Jay
Subject: RE: PRV Sampling

Yeah and there are stacks of others as well. Will bring you up to speed on it when you get back. Do we have the summary of Morton's paper.

-----Original Message-----

From: Parsons, Jay
Sent: December 14, 2017 4:08 PM
To: Moore, Wayne <Wayne.Moore@dfo-mpo.gc.ca>
Subject: FW: PRV Sampling
Importance: High

fyi

-----Original Message-----

From: Taylor, Nathan
Sent: December-14-17 3:55 PM
To: Parsons, Jay
Subject: Fw: PRV Sampling
Importance: High

Hey Jay,

Further to your earlier inquiry see below for the most complete response I can provide right now. We'll respond the request (within the domain where we're qualified) with a CSAS Science response.

Hope that's helpful!

NG

----- Original Message -----

From: Miller-Saunders, Kristi

Sent: Thursday, December 14, 2017 08:52 AM

To: Lowe, Carmel; Taylor, Nathan

Subject: FW: PRV Sampling

Here is the respond to the question you asked Carmel. My lab is cpntri bring to the first and second bullets but they will need a broader array of expertise for the third and fourth bullets. Our test results should be complete today.

Please forward to Leslie as I am working from my phone.
Kristi

From: Austin, Joyce ENV:EX [Joyce.Austin@gov.bc.ca]

Sent: December 13, 2017 11:53 AM

To: Miller-Saunders, Kristi; Tabata, Amy; Tesch, David ENV:EX; 'Russell, Ken (EC)'

Cc: Hunse, Laura A ENV:EX; McRae, Jake (EC); Freyman, Liz ENV:EX

Subject: RE: PRV Sampling

Hello Kristi,

Thank you for your email and presentation materials. The BC Ministry of Environment & Climate Change Strategies (ENV), Environmental Protection Regional Operations Branch needs the expertise within DFO to:

- Analyze effluent samples collected from two fish processing plants on December 4 and 5, 2017. EPD may require further effluent analyses as part of an upcoming compliance audit of fish processing plants in B.C.
- Assess the PVR data results of presence/absence and if present, to determine whether to test for live virus infectivity. From the information and scientific literature you provided, we understand that virus presence in effluent to the marine environment is a risk to wild salmon.
- Provide recommendations for marine effluent discharge viral load levels; if the virus levels are a problem, what can be done to minimize impacts and protect the environment. What kind of effluent treatment is recommended for marine discharges? Are there proxy parameters to test?
- Provide information to guide provincial government policy with respect to public health and safety as well as protection of the environment, which could include compliance and enforcement.

This is a high priority for the ENV Minister and receiving the results and interpretation are critical for us. Laura Hunse has been designated the person to receive the results although my group is working together with me to respond to questions that are coming from our executive team.

Please don't hesitate to contact me, Laura or Liz if you require more information.

Regards,

Joyce Austin, Ph.D.

Senior Provincial Laboratory Specialist (Unit Head) Environmental Monitoring, Reporting & Economics Knowledge Management Branch | Ministry of Environment & Climate Change Strategy Mailing address : PO Box 9347 STN PROV GOVT, Victoria, BC V8W 9M1 Physical address : 525 Superior St, Victoria, BC V8V 1T7

Tel.: 778-698-4434;

Cel.: [REDACTED]

Fax: 250-356-7197<tel:250-387-5757>

From: Miller-Saunders, Kristi [mailto:Kristi.Saunders@dfo-mpo.gc.ca]

Sent: Tuesday, December 12, 2017 1:47 PM

To: Austin, Joyce ENV:EX; Tabata, Amy; Tesch, David ENV:EX; 'Russell, Ken (EC)'

Cc: Hunse, Laura A ENV:EX; McRae, Jake (EC)

Subject: RE: PRV Sampling

Joyce and David,

I have been requested by our regional director of science, Carmel Lowe, to ask you how you propose to use the results we provide in your aquaculture review or otherwise. This is important for us to document/understand internally, and provide answers to our management hierarchy. She would also like to know whether we can anticipate any additional requests for support in near future.

I should have put your request through a formal channel for advice, which I believe is taking place now.

Thanks,

Kristi Miller

Kristi Miller-Saunders, PhD

Head, Molecular Genetics

Pacific Biological Station

3190 Hammond Bay Rd

Nanaimo BC V9T 6N7

250-756-7155

Kristi.Saunders@dfo-mpo.gc.ca<mailto:Kristi.Saunders@dfo-mpo.gc.ca>

From: Austin, Joyce ENV:EX [mailto:Joyce.Austin@gov.bc.ca]

Sent: December-11-17 10:58 AM

To: Tabata, Amy; Tesch, David ENV:EX; 'Russell, Ken (EC)'

Cc: Hunse, Laura A ENV:EX; McRae, Jake (EC); Miller-Saunders, Kristi

Subject: RE: PRV Sampling

s.16(2)(c)

Hi Amy,

I have already contacted Kristi Miller and I'm waiting on her to give me a call back,

Thanks

Joyce Austin, Ph.D.

Senior Provincial Laboratory Specialist (Unit Head) Environmental Monitoring, Reporting & Economics Knowledge Management Branch | Ministry of Environment & Climate Change Strategy Mailing address : PO Box 9347 STN PROV GOVT, Victoria, BC V8W 9M1 Physical address : 525 Superior St, Victoria, BC V8V 1T7

Tel.: 778-698-4434;

Cel.: [REDACTED]

Fax: 250-356-7197<tel:250-387-5757>

From: Tabata, Amy [mailto:Amy.Tabata@dfo-mpo.gc.ca]

Sent: Monday, December 11, 2017 10:55 AM

To: Tesch, David ENV:EX; 'Russell, Ken (EC)'

Cc: Austin, Joyce ENV:EX; Hunse, Laura A ENV:EX; McRae, Jake (EC); Miller-Saunders, Kristi

Subject: RE: PRV Sampling

We are currently processing the samples, and expect results in the next few days.

Please contact

Dr Kristi Miller – Head – Molecular Genetics Lab, cc'd above or by phone at 250-756-7155

Thanks

Amy Tabata

Molecular Genetics Technician

Fisheries and Oceans, Canada

Pacific Biological Station

3190 Hammond Bay Road

Nanaimo, B.C. V9T 6N7

ph. 250-756-3369

fax 250-756-7031

email amy.tabata@dfo-mpo.gc.ca<mailto:amy.tabata@dfo-mpo.gc.ca>

From: Tesch, David ENV:EX [mailto:David.Tesch@gov.bc.ca]

Sent: December-11-17 10:35 AM

To: 'Russell, Ken (EC)'

Cc: Austin, Joyce ENV:EX; Hunse, Laura A ENV:EX; Tabata, Amy; McRae, Jake (EC)

Subject: RE: PRV Sampling

Thanks Ken,

s.16(2)(c)

I've been able to get a hold of Joyce and she is going to give DFO a call.

Regards,

D.

From: Russell, Ken (EC) [mailto:ken.russell@canada.ca]
Sent: Monday, December 11, 2017 10:29 AM
To: Tesch, David ENV:EX
Cc: Austin, Joyce ENV:EX; Hunse, Laura A ENV:EX; Tabata, Amy (Amy.Tabata@dfo-mpo.gc.ca<mailto: Amy.Tabata@dfo-mpo.gc.ca>); McRae, Jake (EC)
Subject: RE: PRV Sampling

Good morning David,

I am not sure of the analysis time line for the PRV. Your best contact at this point in time would be Laura Hunse – who is in contact with Amy Tabata. Ms. Tabata is the DFO molecular geneticist technician who accompanied us during the sampling. I have CCed Ms. Hunse and Ms. Tabata on this Email.

I hope this helps

Ken Russell
Senior Enforcement Officer – Enforcement Branch Environment and Climate Change Canada / Government of Canada
ken.russell@canada.ca<mailto:ken.russell@canada.ca> / Tel : 250 756 7251 / Cell : [REDACTED]

Ken Russell,
Agent d'application de la loi Supérieur, Direction générale de l'application de la loi Environnement et Changement Climatique / Gouvernement du Canada ken.russell@canada.ca<mailto:ken.russell@canada.ca> / Tel. : 250 756 7251 / Tel. Cell : [REDACTED]

From: Tesch, David ENV:EX [mailto:David.Tesch@gov.bc.ca]
Sent: December 11, 2017 9:12 AM
To: Russell, Ken (EC)
Cc: Austin, Joyce ENV:EX
Subject: PRV Sampling
Importance: High

Hi Ken,

My name is David Tesch and I am Joyce's Executive Director. Joyce is not in the office today and my DM is asking if there is an ETA on the results from the PRV sampling that was done at the fish farms early last week. Are you able to provide me an answer?

Regards,
David Tesch
Executive Director
Knowledge Management Branch
Ministry of Environment & Climate Change Strategy
778-698-4406
David.Tesch@gov.bc.ca<mailto:David.Tesch@gov.bc.ca>

s.16(2)(c)

Dickie, Catherine

From: Lowe, Carmel
Sent: December 14, 2017 6:29 PM
To: Moore, Wayne; Taylor, Nathan
Subject: Re: Request for call re: SSHI data

Hope we can add this to our discussion on Monday....

Sent from my BlackBerry 10 smartphone on the Rogers network.

From: Moore, Wayne
Sent: Thursday, December 14, 2017 17:22
To: Taylor, Nathan; Lowe, Carmel
Subject: Re: Request for call re: SSHI data

I suspect that there thinking is that it seems ever time something bad is found (eg, hsmi piece) the datat is released with an article but that all the other findings (ie, the data that led her to stop testing for reportables) never seems to get share/published. I suspect there concern is they would like to see more transparency.

Sent from my BlackBerry 10 smartphone on the Rogers network.

From: Taylor, Nathan
Sent: Thursday, December 14, 2017 8:09 PM
To: Lowe, Carmel; Moore, Wayne
Subject: RE: Request for call re: SSHI data

No clue I'm afraid and there are many possibilities.

From: Lowe, Carmel
Sent: Thursday, December 14, 2017 5:06 PM
To: Taylor, Nathan; Moore, Wayne
Subject: FW: Request for call re: SSHI data

Do either of you know what data he might be referring to and any plans for its release?

Carmel

Carmel Lowe, Ph.D.
Regional Director Science | Directrice régionale des sciences
Fisheries and Oceans Canada | Pêches et Océans Canada
Pacific Biological Station | Station biologique du Pacifique
3190 Hammond Bay Rd, Nanaimo, BC, Canada V9T 6N7
Carmel.Lowe@dfo-mpo.gc.ca
Telephone | Téléphone 250-756-7177
Facsimile | Télécopieur 250-729-8360
Government of Canada | Gouvernement du Canada

From: Reid, Rebecca
Sent: Thursday, December 14, 2017 4:02 PM
To: Lowe, Carmel <Carmel.Lowe@dfo-mpo.gc.ca>
Cc: Johal, Sharan <Sharan.Johal@dfo-mpo.gc.ca>
Subject: FW: Request for call re: SSHI data

Can you advise on this? I'm not familiar with the details.

Thanks.

RR

Rebecca Reid
Regional Director General/ Directrice générale régionale
Fisheries and Oceans Canada - Pacific Region/ Pêches et Océans Canada - Région du Pacifique
200-401 Burrard Street / 401, rue Burrard, bureau 200
Vancouver, BC/CB V6C 3S4
Office / Téléphone: 604-666-6098
Cell / Cellulaire: [REDACTED]
E-mail/ Courriel: rebecca.reid@dfo-mpo.gc.ca

From: [REDACTED]
Sent: Thursday, December 14, 2017 3:43 PM
To: Reid, Rebecca <Rebecca.Reid@dfo-mpo.gc.ca>
Cc: [REDACTED]
Subject: Request for call re: SSHI data

Hi Rebecca,

I'm hoping you might be available for a call with [REDACTED] and myself. We are hopeful that you might be able to help expedite the release of data held by the Strategic Salmon Health Initiative research team. We understand this is a collaborative research project, but DFO is doing the primary diagnostics. Given the paper published yesterday by Morton and Routledge we believe this data is important from a public perspective, as well as an aquaculture management perspective.

Please let us know if you can be available, I don't think we would need more than 30 minutes.

[REDACTED]

--

[REDACTED]
BC Salmon Farmers Association
Office: (250) 286-1636 x [REDACTED]
Mobile: [REDACTED]
[REDACTED]
BCSalmonFarmers.ca
Twitter: [REDACTED]

Disclaimer: The contents of this email and any attachments are confidential to the intended recipient and must not be used or copied to unauthorized third parties in any way. If you are not the intended recipient, please notify the sender and delete the message and its content immediately.

Dickie, Catherine

From: Miller-Saunders, Kristi
Sent: December 18, 2017 8:53 AM
To: MacDougall, Lesley; Lowe, Carmel; Taylor, Nathan
Subject: RE: RSR2017_AQU01_Browns%20and%20TofinoPRV_Final

I am good with the change
Kristi

-----Original Message-----

From: MacDougall, Lesley
Sent: December-18-17 8:18 AM
To: Lowe, Carmel; Miller-Saunders, Kristi; Taylor, Nathan
Subject: RE: RSR2017_AQU01_Browns%20and%20TofinoPRV_Final

Hi all; I agree with Carmel's change as well

Kristi - as soon as we've heard from you I can get a final copy to Carmel for approval

Cheers
Lesley

-----Original Message-----

From: Lowe, Carmel
Sent: 2017-December-18 7:03 AM
To: Miller-Saunders, Kristi; MacDougall, Lesley; Taylor, Nathan
Subject: Re: RSR2017_AQU01_Browns%20and%20TofinoPRV_Final

Thanks Lesley and Kristi. Nathan - I didn't hear from you so assuming you are comfortable...

Rather than Lesley's suggestion, I propose the following addition to final context piece:

'Further Science studies would be required to determine and evaluate any associated marine environmental or public health risks associated with such effluent discharges.'

Comments before 9:30 am please.
Carmel

Sent from my BlackBerry 10 smartphone on the Rogers network.

Original Message
From: Miller-Saunders, Kristi
Sent: Saturday, December 16, 2017 11:10
To: MacDougall, Lesley; Lowe, Carmel; Taylor, Nathan
Subject: RE: RSR2017_AQU01_Browns%20and%20TofinoPRV_Final

Here is a final copy with all tracking and comments removed.
Kristi

From: MacDougall, Lesley
Sent: December 16, 2017 9:55 AM
To: Lowe, Carmel; Taylor, Nathan; Miller-Saunders, Kristi
Subject: FW: RSR2017_AQU01_Browns%20and%20TofinoPRV_Final

Hi all, much improved, very minor changes suggested to identify where the genetics lab is.
Otherwise, I am good with this version: one Q - would it be useful in the final context piece to note that we don't really have anything to compare the PRV loads to?

L

From: Lesley MacDougall [REDACTED]
Sent: Saturday, December 16, 2017 9:47 AM
To: MacDougall, Lesley
Subject: RSR2017_AQU01_Browns%20and%20TofinoPRV_Final

[REDACTED]

s.19(1)

Ryan, Patricia

From: Moore, Wayne
Sent: December-15-17 7:50 AM
To: Parsons, Jay
Subject: Re: The effect of exposure to farmed salmon on piscine orthoreovirus infection and fitness in wild Pacific salmon in British Columbia, Canada

Thx

Sent from my BlackBerry 10 smartphone on the Rogers network.

From: Parsons, Jay
Sent: Friday, December 15, 2017 7:30 AM
To: Moore, Wayne
Cc: Lowe, Carmel; White, Andrea; Taylor, Nathan; Kennedy, Eddy; Johnson, Stewart; Bungay, Alfred; Burgetz, Ingrid
Subject: RE: The effect of exposure to farmed salmon on piscine orthoreovirus infection and fitness in wild Pacific salmon in British Columbia, Canada

Wayne,

Please find attached a short review of the PRV paper by Morton et al. which was published on December 13th, 2017. If you require a more thorough review of the paper and additional information on our ongoing research on PRV please let us know.

Thanks to Stewart, Kyle, Simon, and others for helping to put these comments together on short notice.

Jay

From: Moore, Wayne
Sent: December-14-17 8:32 AM
To: Bungay, Alfred; Parsons, Jay
Cc: Lowe, Carmel; White, Andrea
Subject: Fw: The effect of exposure to farmed salmon on piscine orthoreovirus infection and fitness in wild Pacific salmon in British Columbia, Canada

Need a summary and observations plus link to our work today cob

Parsons, Jay

From: Moore, Wayne
Sent: Friday, December 15, 2017 9:43 AM
To: McPherson, Arran; Lowe, Carmel; LaRue, Jean-François
Cc: Taylor, Nathan; Garver, Kyle; Johnson, Stewart; Jones, Simon; Parsons, Jay
Subject: Review of Morton article

Please find below a review of the Morton article prepared by Jay's team with input from regional scientists (particularly, Kyle, Simon, and Stewart). Thanks to all for the timely work.

==

Summary of: The effect of exposure to farmed salmon on piscine orthoreovirus infection and fitness in wild Pacific salmon in British Columbia, Canada

A new paper published in the open access journal PlosOne had the objective of conducting an analysis fish health data from BC farmed Atlantic Salmon and wild Pacific salmon to determine if there is a linked between PRV infections in wild and farmed salmon. This was assessed by analysing farmed fish obtained from fish market stores and opportunistically sampling wild salmon from regions defined as "high or low exposure" to salmon farms.

The authors are suggesting that their results indicate that PRV transfer is occurring from farmed Atlantic salmon to wild Pacific salmon, that infection in farmed salmon may be influencing infection rates in wild salmon, and that this may pose a risk of reduced fitness in wild salmon impacting their survival and reproduction. However, they do note in their conclusions that "The evidence, based solely on molecular screening tests from this observational study, and constrained by limited access to farmed Atlantic salmon samples of known provenance, cannot be definitive."

General comments

It is important to highlight a number of points and assumptions arising from this study that may lead to a different interpretation of the findings and conclusions, including that the farmed salmon samples were obtained from fish market stores and thus the actual origin of the farmed fish is unknown.

It is already known in the literature that PRV infections occur in farmed Atlantic salmon and wild Pacific salmon in BC and that there can be differences in PRV infections between species differences and between stocks. However, in their analyses, it is not clear how the data on Pacific salmon have been combined or if it is even the same species composition or stock composition among their samples or areas. Hence, reported difference between areas could actually be attributable to factors other than "area".

The title of the paper and the article assert that the authors are examining the "fitness" in wild Pacific salmon. However, they are not actually examining fitness. Rather they are simply suggesting that because there may be a link between farmed salmon PRV infections and infections in wild salmon, and that based on observations of the impacts of PRV on farmed Norwegian salmon, they are suggesting there may be similar

impacts on wild Pacific salmon in BC and this may lead to impacts on “fitness”. The current body of knowledge on PRV in BC nor the findings of their own study (including their own concluding comments that the evidence is not definitive), do not support any conclusive conclusions from this study.

The comments reported in the news article does not accurately reflect the contents of the paper. A more detailed analysis of the paper and comparison of comments in the news article versus the paper is below.

CBC Article: The research is the first of its kind to conclude that large numbers of B.C's wild salmon are becoming infected with PRV through exposure to fish farms.

Journal Article The author states: “PRV infection was highest among the farmed salmon categories; Atlantic salmon (95%) and steelhead (69%). The highest proportions of PRV-infected wild salmonids were from the high exposure regions, i.e., Regions 5–8, including the lake with a steelhead farm and the highly exposed inshore archipelago environments (37–50%). The proportion of PRV infection declined between the highly exposed lower (41%) and upper (22%) Fraser River. The lowest proportions were in Regions 1 and 2, furthest from salmon farms (5%). In addition, Cultus Lake trout were highly infected with PRV (76%) (Lake c, Fig 1), while only 3% of the salmonids in Oweekeno Lake were infected with PRV (Lake a, Fig 1, S1 Table).”

CBC Article: According to the research, PRV was found to be much more prevalent in the lower Fraser River than the upper Fraser River. "This suggests that salmon infected with PRV are less capable of swimming up through strong rapids in places like Hell's Gate and therefore unable to reach their spawning grounds," said co-author Rick Routledge, a professor of statistics at Simon Fraser University.”

CBC Article: The data also show that the virus makes it more difficult for wild salmon to swim upstream to their spawning grounds, which has major implications for the sustainability of the populations.

Journal Article: The authors state: “there was over a six-fold decline in the estimated proportion of PRV-positive test results from (a) fish in the low-challenge category to (b) those in the high-challenge category. This estimated decline is commensurate with the observed declines (i) between Regions 8 and 9 (the lower and upper Fraser River areas) and (ii) between the lower and higher elevations in Region 1 in northern BC (Table 3)” In the Fraser River, sites within the low-challenge category are below Hells Gate and the high-challenge category sites above Hells Gate. In the case of Skeena River site above major river constrictions are considered high-challenge sites.

Our Concerns:

Upon reviewing their data (Supplementary Table 3) we noticed that there are large differences in the species of salmon tested for PRV between Areas. As an example: In the migration study which compared PRV loads between Area 8 (low challenge) and Area 9 (high challenge) in the Fraser River. Samples in Area 8 were a mix of trout and salmon species (44% Trout/Steelhead, 44% Pink and 8% Chinook salmon, 3% Chum and Sockeye, each), whereas samples from Area 9 were primarily Sockeye (96%) and Chinook Salmon (4%). Similar differences in species composition are seen between the other areas, as well as between years.

We feel that analysis of PRV infection using mixed hosts is a serious flaw in this paper as this assumes that all species have the same likelihood/susceptibility to infection with PRV which we know from published literature is not the case. A recent survey of salmon from Washington State and Alaska by Purcell et al. (2017) reported that findings of PRV RNA were most common in Coho and Chinook salmon. In addition to differences between species differences in age, time in seawater etc. will impact on the risk of PRV infection. It is known for farmed fish that the longer fish are in seawater the higher likelihood they become infected with PRV. Purcell et al. (2017) Fish Dis. 2017;1–9

Other Concerns:

1. The authors fail to provide, with exception of Owekeno Lake, data on the amount/load of PRV present in their samples.
2. The authors do not provide any biological data on the hosts (e.g. date of capture, size, age) which would have help to inform the reader about residence time in seawater.
3. In the case of Area 3 it is likely that some of the fish that they sampled would have originated from systems entering into the Strait of Georgian and therefore would have had to have migrated past salmon farms. This paper doesn't consider aspects of host biology which we feel are critical to the interpretation of their results.
4. They include Area 4 (outer coast of Vancouver Island) as a low farm exposure sites, although 2 sites from which they obtained samples were from an area of salmon farming.

In their conclusions they state: “The evidence, based solely on molecular screening tests from this observational study, and constrained by limited access to farmed Atlantic salmon samples of known provenance, **cannot be definitive**. Nonetheless, we view it as providing an early warning sign of a potentially serious problem that warrants immediate and ongoing research. Research **into the fitness impacts to wild Pacific salmonids of farmed salmon pathogens is needed in wild fish populations in addition to controlled laboratory environments**, and could provide valuable insights useful for the management of critically declining wild salmon populations”

Ongoing DFO Research Efforts

Research on PRV is ongoing at the Pacific Biological Station. Current work includes an ACRDP-funded project lead by Dr. Kyle Garver (PBS-Science) and Dr. A.P. Farrell (UBC). This project is examining the effects of PRV on physiological performance of Atlantic and Sockeye Salmon. There are also several projects under PARR lead by Dr. Garver investigating linkage between PRV and HSMI and impacts on Pacific salmon. And applications have been made by Drs. Garver and Johnson for funding to examine sources/reservoirs of PRV and survival/distribution of PRV in the environment.

Wayne Moore

*Director General, Strategic and Regulatory Science
Fisheries and Oceans Canada / Government of Canada
Wayne.Moore@dfo-mpo.gc.ca / Tel: 613-990-0001*

Directeur général, Sciences stratégiques et réglementaires

Pêches et Océans Canada / Gouvernement du Canada
Wayne.Moore@dfo-mpo.gc.ca / Tél. : 613-990-0001

Web: DFO/MPO

Twitter: DFO/MPO/DFO-Science/MPO-Science

Ryan, Patricia

From: Moore, Wayne
Sent: December-15-17 2:29 PM
To: Taylor, Nathan
Subject: Re: could you please call me?

Will call in 30

Sent from my BlackBerry 10 smartphone on the Rogers network.

From: Taylor, Nathan
Sent: Friday, December 15, 2017 2:10 PM
To: Moore, Wayne
Subject: could you please call me?

When you got a sec to talk about media lines etc.?

Nathan G. Taylor, Ph.D.
Division Manager | Directeur de secteur
Aquatic Diagnostics Genomics and Technology Division | Division des diagnostics, la genomique, de la technologie
aquatique
Fisheries and Oceans Canada | Peches et Oceans Canada
Pacific Biological Station | Station biologique du Pacifique
250-756-7395

Ryan, Patricia

From: Moore, Wayne
Sent: December-15-17 3:16 PM
To: Taylor, Nathan
Subject: Re: FOR URGENT APPROVAL: MLs of Effluent Testing

Categories: ATIP

You are on line 6139900001

Sent from my BlackBerry 10 smartphone on the Rogers network.

From: Taylor, Nathan
Sent: Friday, December 15, 2017 3:09 PM
To: Moore, Wayne
Subject: RE: FOR URGENT APPROVAL: MLs of Effluent Testing

I'd appreciate the call anyway!

From: Moore, Wayne
Sent: Friday, December 15, 2017 12:09 PM
To: Taylor, Nathan
Subject: Re: FOR URGENT APPROVAL: MLs of Effluent Testing

Ok.

Sent from my BlackBerry 10 smartphone on the Rogers network.

From: Taylor, Nathan
Sent: Friday, December 15, 2017 2:46 PM
To: Moore, Wayne
Subject: RE: FOR URGENT APPROVAL: MLs of Effluent Testing

I certainly agree with that – there's some other information that Michelle sent up that's just plain wrong that needs to be fixed hence the reason for this email/call

From: Moore, Wayne
Sent: Friday, December 15, 2017 11:45 AM
To: Taylor, Nathan
Subject: Fw: FOR URGENT APPROVAL: MLs of Effluent Testing

Sent from my BlackBerry 10 smartphone on the Rogers network.

From: Fagan, Ashley <Ashley.Fagan@dfo-mpo.gc.ca>
Sent: Friday, December 15, 2017 2:38 PM
To: McPherson, Arran; Morel, Philippe; Moore, Wayne; LaRue, Jean-François
Cc: White, Andrea; Richter, Julie; Villeneuve, Anne-Marie; Smith, Kathleen; Jenkins, Phil; Chow, Vance; Girouard, Louise; Rainer, Michelle; Saindon, Carole

Subject: RE: FOR URGENT APPROVAL: MLs of Effluent Testing

Ok thanks Arran, we'll remove those two lines.

From: McPherson, Arran

Sent: December-15-17 2:34 PM

To: Fagan, Ashley; Morel, Philippe; Moore, Wayne; LaRue, Jean-François

Cc: White, Andrea; Richter, Julie; Villeneuve, Anne-Marie; Smith, Kathleen; Jenkins, Phil; Chow, Vance; Girouard, Louise; Rainer, Michelle; Saindon, Carole

Subject: RE: FOR URGENT APPROVAL: MLs of Effluent Testing

Hi, I really question the need to include the following 2 bullets

Further, have we clarified if there is any issue with our release (through CSAS) of the report we provide to the province?
I think this is the next question that would be asked. Arran.

From: Fagan, Ashley

Sent: Friday, December 15, 2017 2:09 PM

To: Morel, Philippe <Philippe.Morel@dfo-mpo.gc.ca>; Moore, Wayne <Wayne.Moore@dfo-mpo.gc.ca>; McPherson, Arran <Arran.McPherson@dfo-mpo.gc.ca>; LaRue, Jean-François <Jean-Francois.LaRue@dfo-mpo.gc.ca>

Cc: White, Andrea <Andrea.White@dfo-mpo.gc.ca>; Richter, Julie <Julie.Richter@dfo-mpo.gc.ca>; Villeneuve, Anne-Marie <Anne-Marie.Villeneuve@dfo-mpo.gc.ca>; Smith, Kathleen <Kathleen.Smith@dfo-mpo.gc.ca>; Jenkins, Phil <Phil.Jenkins@dfo-mpo.gc.ca>; Chow, Vance <Vance.Chow@dfo-mpo.gc.ca>; Girouard, Louise <Louise.Girouard@dfo-mpo.gc.ca>; Rainer, Michelle <Michelle.Rainer@dfo-mpo.gc.ca>; Saindon, Carole <Carole.Saindon@dfo-mpo.gc.ca>

Subject: RE: FOR URGENT APPROVAL: MLs of Effluent Testing

Thank you. We are moving these to DMO.

From: Morel, Philippe

Sent: December-15-17 2:04 PM

To: Moore, Wayne; Fagan, Ashley; McPherson, Arran; LaRue, Jean-François

Cc: White, Andrea; Richter, Julie; Villeneuve, Anne-Marie; Smith, Kathleen; Jenkins, Phil; Chow, Vance; Girouard, Louise; Rainer, Michelle; Saindon, Carole

Subject: RE: FOR URGENT APPROVAL: MLs of Effluent Testing

Agree and approved

s.21(1)(a)

s.21(1)(b)

Philippe

De : Moore, Wayne

Envoyé : 15 décembre 2017 13:56

À : Fagan, Ashley <Ashley.Fagan@dfo-mpo.gc.ca>; McPherson, Arran <Arran.McPherson@dfo-mpo.gc.ca>; Morel, Philippe <Philippe.Morel@dfo-mpo.gc.ca>; LaRue, Jean-François <Jean-Francois.LaRue@dfo-mpo.gc.ca>

Cc : White, Andrea <Andrea.White@dfo-mpo.gc.ca>; Richter, Julie <Julie.Richter@dfo-mpo.gc.ca>; Villeneuve, Anne-Marie <Anne-Marie.Villeneuve@dfo-mpo.gc.ca>; Smith, Kathleen <Kathleen.Smith@dfo-mpo.gc.ca>; Jenkins, Phil

<Phil.Jenkins@dfo-mpo.gc.ca>; Chow, Vance <Vance.Chow@dfo-mpo.gc.ca>; Girouard, Louise <Louise.Girouard@dfo-mpo.gc.ca>; Rainer, Michelle <Michelle.Rainer@dfo-mpo.gc.ca>; Saindon, Carole <Carole.Saindon@dfo-mpo.gc.ca>
Objet : Re: FOR URGENT APPROVAL: MLs of Effluent Testing

Mitigate "any" risk to the environment. Otherwise ok

Sent from my BlackBerry 10 smartphone on the Rogers network.

From: Fagan, Ashley

Sent: Friday, December 15, 2017 1:49 PM

To: McPherson, Arran; Moore, Wayne; Morel, Philippe; LaRue, Jean-François

Cc: White, Andrea; Richter, Julie; Villeneuve, Anne-Marie; Smith, Kathleen; Jenkins, Phil; Chow, Vance; Girouard, Louise; Rainer, Michelle; Saindon, Carole

Subject: FOR URGENT APPROVAL: MLs of Effluent Testing

Arran, Wayne, Philippe, JF:

MINO has urgently requested the below media lines for **2pm**. Please let us know **ASAP** if you have any concerns as we'll need to move this to DMO shortly. Approved by Carmel Lowe and Rebecca Reid.

Thanks,

Ashley

Issue: In November, a video that shows blood and other effluent coming from a farmed fish processing plant in Brown's Bay, BC was released. The video has received considerable media attention and has raised concerns about the possible presence of disease and pathogens in the discharge, particularly PRV. Media lines are required to explain DFO's role in testing and analyzing samples from the effluent collected from two BC fish processing plants.

Deadline: ASAP

Recommendation: A proactive approach is recommended with Carmel Lowe, RD Science, as spokesperson

Approved by: Carmel Lowe, Rebecca Reid

Media lines:

- At the request of the BC Ministry of Environment & Climate Change Strategies (ENV), Fisheries and Oceans Canada (DFO) is analyzing samples that collected from two BC fish processing plants.
- The samples are being analyzed for the presence or absence of piscine reovirus (PRV) at the DFO Forensics Laboratory at the Pacific Biological Station in Nanaimo, BC.
- This is a secure, restricted-access and restricted-use laboratory, where strict protocols are followed to ensure sample integrity.

• The Province of BC, the Canadian Food Inspection Agency, and Environment and Climate Change Canada and are responsible for the licensing and regulation of fish processing facilities and related effluent. DFO has the lead federal role in managing Canada's fisheries and supports sustainable aquatic ecosystems through habitat protection, oceans management and ecosystems research.

s.21(1)(a)

s.21(1)(b)

Ashley Fagan

Senior Communications Advisor | Conseillère principale en communications

Fisheries and Oceans Canada | Pêches et Océans Canada
ashley.fagan@dfo-mpo.gc.ca
613-990-9415

Dickie, Catherine

From: MacDougall, Lesley
Sent: December 16, 2017 9:55 AM
To: Lowe, Carmel; Taylor, Nathan; Miller-Saunders, Kristi
Subject: FW: RSR2017_AQU01_Browns%20and%20TofinoPRV_Final
Attachments: RSR2017_AQU01_Browns%20and%20TofinoPRV_Final.docx

Hi all, much improved, very minor changes suggested to identify where the genetics lab is.
Otherwise, I am good with this version: one Q - would it be useful in the final context piece to note that we don't really have anything to compare the PRV loads to?
L

From: Lesley MacDougall [REDACTED]
Sent: Saturday, December 16, 2017 9:47 AM
To: MacDougall, Lesley
Subject: RSR2017_AQU01_Browns%20and%20TofinoPRV_Final

[REDACTED]

s.19(1)

Centre for Science Advice Pacific

FPP non-CSAS Request for Rapid Science Response

Request Contact:	David A. Johnson	Project Type: Aquaculture-Emergency response
Date of request: footprint:	December 15, 2017	Project
Region of proposed impact:	Tofino and Browns Bay, British Columbia	Habitat Type: Coastal
Purpose of request:	Information for Ministry of Environment / Environment and Climate Change Canada investigation	
Potential affected species:	Pacific salmon	
Date required:	December 15, 2017	Request #:2017AQU01

Timeline rationale:

PROJECT OVERVIEW

In Canada, the regulation of processing of fish products is a shared Provincial – Federal responsibility. BC Ministry of Environment & Climate Change Strategies (ENV) supports marine fisheries and aquaculture and seafood industry development, issuing ~~fish~~ licenses to businesses involved in the aquaculture sector - including permits for seafood processing facilities - under the BC Fisheries Act and Fish Inspection Act. While the conditions of ~~the~~ license include the requirement to construct and operate the facility to ensure that activities are conducted in a manner that will prevent fish and aquatic plants from becoming unsafe food, there is no prohibition of the discharge of fish waste effluent, or requirement of specific treatment of fish waste effluent prior to discharge into the environment. Thus, as a function of normally operating fish processing plants, fish waste effluent is released back into the marine ecosystem subject to conditions of ~~the~~ license.

Environment and Climate Change Canada (ECCC) administers section 36 of DFO's Fisheries Act, the key pollution prevention provision, prohibiting the deposit of deleterious substances into waters frequented by fish, unless authorized by regulations under the Fisheries Act or other federal legislation. A deleterious substance can be any substance that, if added to any water, would degrade or alter its quality such that it could be harmful to fish, fish habitat or the use of fish by people.

Following the public release of a video showing fish waste effluent being released into the marine environment, and subsequent news articles and public interest, ENV initiated an inspection of two fish processing plants that are currently the focus of investigation. ENV also has an upcoming compliance audit for fish processing plants.

The BC Ministry of Environment & Climate Change Strategies (ENV), Environmental Protection Regional Operations Branch requested assistance from DFO to support the collection of water samples at two fish processing facilities, and to test collected effluent for the presence of the Piscine Reovirus (PRV), as part of the ongoing inspection. Other labs contacted at the time did not have the capacity to perform the necessary diagnostics on water samples.

Comment [1]:
Send to AMD to ensure accuracy

Background:

Piscine Orthoreovirus (PRV) is known to be present in Norway, Japan, the United Kingdom, Ireland, Chile, the United States and Canada (Biering and Garseth 2012; Kibenge et al. 2013; Siah et al. 2015). Farmed and wild Atlantic Salmon (*Salmo salar*), Coho Salmon (*Oncorhynchus kisutch*), Chinook Salmon (*Oncorhynchus tshawytscha*), and Rainbow trout (*Oncorhynchus mykiss*), and wild Cutthroat Trout (*Oncorhynchus clarkii*), Steelhead Trout (*Oncorhynchus mykiss*), Sockeye Salmon (*Oncorhynchus nerka*), Chum Salmon (*Oncorhynchus keta*) and Pink Salmon (*Oncorhynchus gorbuscha*) have all tested positive for PRV through molecular testing. However, around the world, PRV prevalence has been substantially higher in farmed populations, most showing 60-90+% prevalence, than in wild populations.

PRV is causative of Heart and Skeletal Muscle Inflammation (HSMI) disease in farmed Atlantic Salmon (Wessell et al. 2017) and EIBS disease in farmed Coho salmon in Japan (Takano et al. 2016). As well, it has been implicated in other diseases of farmed Rainbow Trout, Coho and Chinook Salmon in Chile (Godoy et al. 2016), Norway (Hauge et al. 2017) and Canada (Miller et al. 2017). HSMI disease occurs in farmed Atlantic salmon in Norway (Kongtorp et al. 2004), Scotland (Ferguson et al. 2005), Chile (Godoy et al. 2016), and Canada (Di Cicco et al. 2017).

Red blood cells (RBCs) are the primary infective tissue for PRV (Wessell et al. 2014). Not all salmon carrying the virus, even at high load, are diseased. Given the high prevalence of PRV in farmed populations and presence of the virus in the blood, it was expected that blood effluent from processing plants would contain PRV.

There is a large body of literature that has established the infectivity of PRV in Norway and its co-occurrence with the disease HSMI. More recently, DFO scientists have been investigating the infectivity and disease-causing potential of the strain of PRV present in BC. Their studies have demonstrated that PRV from BC can infect Sockeye, Chinook, and Atlantic Salmon.

After infection, PRV can reach high levels in the blood and is capable of being present for many months; these findings are similar to those from Norwegian challenge studies, however, recent studies indicate that there is uncertainty regarding the potential ability of PRV to cause disease in BC.

DFO scientists, along with provincial and international colleagues, are conducting investigations to better understand the biology of PRV and Heart and Skeletal Muscle Inflammation (HSMI) disease in wild and farmed salmon on the west coast of North America. To date the disease HSMI always occurs in the presence of PRV. While there have been other agents in addition to PRV which have been found in fish with HSMI disease, researchers agree that PRV is one of the leading candidates to be a causative agent.

A study documenting the first farm level diagnosis of HSMI in BC was recently published (Di Cicco et al. 2017). The study showed inflammatory lesions in heart and skeletal muscle tissue diagnostic of this disease in a longitudinal study from one Atlantic Salmon farm in BC. At an individual level, not all fish carried both heart and skeletal lesions at any given point in time, but at the farm level, both were present and diagnostic of the disease.

Request:

Comment [2]:
DFO 2015 is no longer sufficiently accurate, and there are more farmed and wild salmon have been testing than intimated.

Comment [3]:
You simply have to make some statement about linkages with disease.

Comment [4]:
This deviates from the website information – and must be substantiated

As part of an inspection conducted at two fish processing facilities, ENV requested DFO expertise to:

- ☐ Accompany 1 ENV and 1 ECCC inspector to two fish processing facilities and support the collection of water samples;
- ☐ Analyze effluent samples collected from two fish processing plants on December 4 and 5, 2017, and
- ☐ Assess the PVR data results of presence/absence ~~and the results of the PVR data results of presence/absence~~ ~~infectivity.~~

Importance: ☒ Essential ☐ Important ☐ Desirable

SCIENCE RESPONSE

Methods:

A DFO Molecular Genetics technician, ~~Mr. [redacted]~~, accompanied two inspectors (from ENV and ECCC) to each of the fish processing facilities to provide guidance for the appropriate collection of water samples to allow for viral analysis. Also present were ~~Ken [redacted]~~, the Senior Enforcement Officer - Enforcement Branch Environment and Climate Change Canada, and ~~Leanne [redacted]~~, the Environmental Protection Officer - Compliance Section, Environmental Protection Division, BC Ministry of Environment and Climate Change Strategy.

At the Browns Bay Packing Co, Campbell River, BC, effluent was collected from one source – at the plant itself, after it had been passed over a roto-screen of 0.5 mm and 0.25 mm (as per their permit), and immediately prior to discharge out of the facility into the environment. This sample was the combination of discharge from the fish transport vessel (a mixture of saltwater, ice-water and blood from the fish being processed) and the liquid discharge from the plant used in the processing of the fish. The sample was red in colour, with very small particulates visible. This is MGL sample 2017-0017-J3205.

At the Lions Gate Fish Co, Tofino, BC, effluent was collected from two sources;

- 1) ~~discharge~~ Discharge from the fish harvest vessel (a mixture of saltwater, ice-water and blood from the fish being processed). The vessel discharge is un-treated and enters the fish plant discharge pipe after the plant discharge is screened, and so was considered a separate sample by the accompanying inspectors. The sample was bright red in colour, and fairly clear with very little particulate matter visible. This is MGL sample 2017-0017-J3231
- 2) ~~discharge~~ Discharge from the processing plant that was used in the processing and cleaning of fish. This sample was collected after it had passed over a fine-meshed screen (as per their permit) and prior to discharge out into the environment. This sample was had a cloudy, white appearance, with visible particulate matter. This is MGL sample 2017-0017-J3232

Note – one additional discharge from this site was unable to be accessed for sampling. The liquid from the processing plant floor is passed over a 6mm screen, and then joins directly into the pipe for discharge.

~~At the Browns Bay Packing Co, Campbell River, BC, effluent was collected from one source – at the plant itself, after it had been passed over a roto-screen of 0.5 mm and 0.25 mm (as per their permit), and immediately prior to discharge out of the facility into the environment. This sample was the combination of discharge from the fish transport vessel (a mixture of saltwater, ice-water and blood from the fish being processed) and the liquid discharge from the plant used in the processing of the fish. The sample was red in colour, with very small particulates visible. This is MGL sample 2017-0017-J3205.~~

~~At the Lions Gate Fish Co, Tofino, BC, effluent was collected from two sources; 1) discharge from the fish harvest vessel (a mixture of saltwater, ice-water and blood from the fish being processed). The vessel discharge is un-treated and enters the fish plant discharge pipe after the plant discharge is screened, and so was considered a separate sample by the accompanying inspectors. The sample was bright red in colour, and fairly clear with very little particulate matter visible. This is MGL sample 2017-0017-J3231 2) discharge from the processing plant that was used in the processing and cleaning of fish. This sample was collected after it had passed over a fine-meshed screen (as per their permit) and prior to discharge out into the environment. This sample was had a cloudy, white appearance, with visible particulate matter. This is MGL sample 2017-0017-J3232~~

Laboratory

~~The samples collected from the two fish processing facilities were analyzed for the presence of infectious agents using the following methods: 1) PCR (Polymerase Chain Reaction) and 2) Virus Isolation (VI).~~

[Faint, illegible handwritten notes]

Samples were collected in new 2L sample bottles, and were transported to the DFO Molecular Genetics Lab on ice and in a locked truck. They arrived at the lab within 3-6 hours of collection.

Samples from the Fish Plant discharge inspections (MGL AQ# 2017-0017) were ~~not~~ processed in the Molecular Genetics Forensics Lab at the Pacific Biological station, ~~7275 Montezuma Blvd., Bellingham, WA 98226~~.

Details of sample processing methodologies are presented in Appendix 1. Some equipment and protocols related to sample processing were modified when samples were removed from the lab, in which case examples were provided in detail. Detailed information on the equipment and protocols used in the lab is provided in Appendix 1.

[illegible][illegible][illegible]

1. The first part of the document is a letter from the author to the reader, explaining the purpose of the work and the author's motivation. The author states that the work is a result of a long and arduous process of research and reflection, and that it is intended to provide a comprehensive overview of the current state of the field.

2. The second part of the document is a detailed analysis of the current state of the field, covering a wide range of topics and issues. The author discusses the various challenges and opportunities facing the field, and provides a critical evaluation of the existing literature.

3. The third part of the document is a series of recommendations for future research and practice. The author outlines a number of key areas for further investigation, and provides a number of practical suggestions for how these areas can be addressed.

4. The fourth part of the document is a conclusion, in which the author summarizes the main findings of the work and offers some final thoughts on the future of the field.

Results:

Detailed results are presented in Appendix 2A (raw data containing results for all technical replicates) and 2B (synthesized data).

Context:

References:

- Biering E., Garseth A.H. 2012. Heart and Skeletal Muscle Inflammation (HSMI) of farmed Atlantic Salmon (*Salmo salar* L.) and the associated Piscine Reovirus (PRV). In: Feist S, editor. ICES Identification Leaflets for Diseases and Parasites of Fish and Shellfish. Copenhagen: International Council for the Exploration of the Sea; p. 6.
- Di Cicco, E., Ferguson, H.W., Schulze, A.D., Kaukinen, K.H., Li, S., Vanderstichel, R., Wessel, O., Rimstad, E., Gardner, I.A., Hammell, K.L., 2017, Heart and skeletal muscle inflammation (HSMI) disease diagnosed on a British Columbia salmon farm through a longitudinal farm study. PLoS ONE 12, 843 e0171471.
- Ferguson, H.W., Kongtorp, R.T., Taksdal, T., Graham, D. and Falk, K., 2005. An outbreak of disease resembling heart and skeletal muscle inflammation in Scottish farmed salmon, *Salmo salar* L., with observations on myocardial regeneration. Journal of fish diseases, 28(2), pp.119-123.
- Finstad, Ø.W., Dahle, M.K., Lindholm, T.H., Nyman, I.B., Løvoll, M., Wallace, C., Olsen, C.M., Storset, A.K. and Rimstad, E., 2014. Piscine orthoreovirus (PRV) infects Atlantic salmon erythrocytes. *Veterinary research*, 45(1), p.35.

Godoy M.G., Kibenge M.J., Wang Y., Suarez R., Leiva C., Vallejos F., Kibenge F.S. 2016. First description of clinical presentation of piscine orthoreovirus (PRV) infections in salmonid aquaculture in Chile and identification of a second genotype (Genotype II) of PRV. *Virology journal* 13(1): p.98.

Hauge H., Vendramin N., Taksdal T., Olsen A.B., Wessel Ø., Mikkelsen S.S., Alencar A.L.F., Olesen N.J., Dahle M.K. 2017. Infection experiments with novel Piscine orthoreovirus from rainbow trout (*Oncorhynchus mykiss*) in salmonids. *PLoS one* 12(7), p.e0180293.

Kibenge M.J.T., Iwamoto T., Wang Y., Morton A., Godoy M.G., Kibenge F. 2013. Whole-genome analysis of Piscine Reovirus (PRV) shows PRV represents a new genus in Family Reoviridae and its genome segment S1 sequences group it into two separate sub-genotypes. *Virology Journal* 10:230.

Kongtorp R.T., Taksdal T., Lyngøy A. 2004. Pathology of heart and skeletal muscle inflammation (HSMI) in farmed Atlantic salmon *Salmo salar*. *Diseases of Aquatic Organisms* 59:217-224.

Miller, K.M., Günther, O.P., Li, S., Kaukinen, K.H. and Ming, T.J., 2017. Molecular indices of viral disease development in wild migrating salmon. *Conservation Physiology* 5(1).

Siah A., Morrison D.B., Fringuelli E., Savage P., Richmond Z., Johns R., Purcell M.K., Johnson S.C., Saksida S.M. 2015. Piscine reovirus: Genomic and molecular phylogenetic analysis from farmed and wild salmonids collected on the Canada/US Pacific Coast. *PLoS ONE* 10(11):e0141475.

Takano T., Nawata A., Sakai T., Matsuyama T., Ito T., Kurita J., Terashima S., Yasuike M., Nakamura Y., Fujiwara A., Kumagai A. 2016. Full-Genome sequencing and confirmation of the causative agent of Erythrocytic inclusion body syndrome in Coho Salmon identifies a new type of Piscine Orthoreovirus. *PLoS one* 11(10), p.e0165424.

Wessel Ø., Braaen S., Alarcon M., Haatveit H., Roos N., Markussen T., Tengs T., Dahle M.K., Rimstad E. 2017. Infection with purified Piscine orthoreovirus demonstrates a causal relationship with heart and skeletal muscle inflammation in Atlantic salmon. *PLoS one* 12(8), p.e0183781.

Responder: XXXX, Science

Responder:

This response does not constitute delivery of peer – reviewed Science advice; it is intended as a rapid response to an immediate requirement for Science input.

Reviewed by: Lesley MacDougall, Coordinator, Centre for Science Advice Pacific Region

Date: XXXX, 2017

Comments:

Approved by: _____
Date: _____
Comments: _____

Dickie, Catherine

From: Miller-Saunders, Kristi
Sent: December 16, 2017 11:11 AM
To: MacDougall, Lesley; Lowe, Carmel; Taylor, Nathan
Subject: RE: RSR2017_AQU01_Browns%20and%20TofinoPRV_Final
Attachments: RSR2017_AQU01_Browns%20and%20TofinoPRV_Final-AC.docx

Here is a final copy with all tracking and comments removed.
Kristi

From: MacDougall, Lesley
Sent: December 16, 2017 9:55 AM
To: Lowe, Carmel; Taylor, Nathan; Miller-Saunders, Kristi
Subject: FW: RSR2017_AQU01_Browns%20and%20TofinoPRV_Final

Hi all, much improved, very minor changes suggested to identify where the genetics lab is.
Otherwise, I am good with this version: one Q - would it be useful in the final context piece to note that we don't really have anything to compare the PRV loads to?
L

From: Lesley MacDougall [REDACTED]
Sent: Saturday, December 16, 2017 9:47 AM
To: MacDougall, Lesley
Subject: RSR2017_AQU01_Browns%20and%20TofinoPRV_Final

[REDACTED]

s.19(1)

Centre for Science Advice Pacific

FPP non-CSAS Request for Rapid Science Response

Request Contact:	Donna Gibson	Project Type: Aquaculture-Emergency response
Date of request:	November 29, 2017	Project footprint:
Region of proposed impact:	Tofino and Browns Bay, British Columbia	Habitat Type: Coastal
Purpose of request:	Information for Ministry of Environment / Environment and Climate Change Canada investigation	
Potential affected species:	Pacific salmon	
Date required:	December 15, 2017	Request #:2017AQU01

Timeline rationale:

PROJECT OVERVIEW

In Canada, the regulation of processing of fish products is a shared Provincial – Federal responsibility. BC Ministry of Environment & Climate Change Strategies (ENV) supports marine fisheries and aquaculture and seafood industry development, issuing licenses to businesses involved in the aquaculture sector - including permits for seafood processing facilities - under the *BC Fisheries Act and Fish Inspection Act*. Thus, as a function of normally-operating fish processing plants, fish waste effluent is released back into the marine ecosystem subject to conditions of license.

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The BC Ministry of Environment & Climate Change Strategies (ENV), Environmental Protection Regional Operations Branch requested assistance from DFO to support the collection of water samples at two fish processing facilities, and to test collected effluent for the presence of the Piscine OrthoReovirus (PRV), as part of the ongoing inspection. Other labs contacted at the time did not have the capacity to perform the necessary diagnostics on water samples.

1. QUESTION

Background:

Piscine OrthoReovirus (PRV) is known to be present in Norway, Japan, the United Kingdom, Ireland, Chile, the United States and Canada (Biering and Garseth 2012; Kibenge et al. 2013; Siah et al. 2015). Farmed and wild Atlantic Salmon (*Salmo salar*), Coho Salmon (*Oncorhynchus kisutch*), Chinook Salmon (*Oncorhynchus tshawytscha*), and Rainbow trout

(*Oncorhynchus mykiss*), and wild Cutthroat Trout (*Oncorhynchus clarkii*), Steelhead Trout (*Oncorhynchus mykiss*), Sockeye Salmon (*Oncorhynchus nerka*), Chum Salmon (*Oncorhynchus keta*) and Pink Salmon (*Oncorhynchus gorbuscha*) have all tested positive for PRV through molecular testing. However, around the world, PRV prevalence has been substantially higher in farmed populations, most showing 60-90+% prevalence, than in wild populations.

PRV is causative of Heart and Skeletal Muscle Inflammation (HSMI) disease in farmed Atlantic Salmon (Wessell et al. 2017) and EIBS disease in farmed Coho salmon in Japan (Takano et al 2016). As well, it has been implicated in other diseases of farmed Rainbow Trout, Coho and Chinook Salmon in Chile (Godoy et al. 2016), Norway (Hauge et al. 2017) and Canada (Miller et al. 2017). HSMI disease occurs in farmed Atlantic salmon in Norway (Kongtorp et al. 2004), Scotland (Ferguson et al. 2005), Chile (Godoy et al. 2016), and Canada (Di Cicco et al. 2017).

Red blood cells (RBCs) are the primary infective tissue for PRV (Finstad et al. 2014). Not all salmon carrying the virus, even at high load, are diseased. Given the high prevalence of PRV in farmed populations and presence of the virus in the blood, it was expected that blood effluent from processing plants would contain PRV.

Request:

As part of an inspection conducted at two fish processing facilities, ENV requested DFO expertise to:

- ☐ Accompany 1 ENV and 1 ECCC inspector to two fish processing facilities and support the collection of water samples;
- ☐ Analyze effluent samples collected from two fish processing plants on December 4 and 5, 2017; and
- ☐ Assess the PVR data results of presence/absence

Importance:

☒ Essential

☐ Important

☐ Desirable

SCIENCE RESPONSE

Methods:

A DFO Molecular Genetics technician accompanied two inspectors (from ENV and ECCC) to each of the fish processing facilities to provide guidance for the appropriate collection of water samples to allow for viral analysis. Also present were the Senior Enforcement Officer - Enforcement Branch Environment and Climate Change Canada, and the Environmental Protection Officer - Compliance Section, Environmental Protection Division, BC Ministry of Environment and Climate Change Strategy.

At the Browns Bay Packing Co, Campbell River, BC, effluent was collected from one source – at the plant itself, after it had been passed over a roto-screen of 0.5 mm and 0.25 mm (as per their permit), and immediately prior to discharge out of the facility into the environment. This sample was the combination of discharge from the fish transport vessel (a mixture of saltwater, ice-water and blood from the fish being processed) and the liquid discharge from the plant used in the processing of the fish. The sample was red in colour, with very small particulates visible. This is MGL sample **2017-0017-J3205**.

At the Lions Gate Fish Co, Tofino, BC, effluent was collected from two sources;

- 1) Discharge from the fish harvest vessel (a mixture of saltwater, ice-water and blood from the fish being processed). The vessel discharge is un-treated and enters the fish plant discharge pipe after the plant discharge is screened, and so was considered a separate sample by the accompanying inspectors. The sample was bright red in colour, and fairly clear with very little particulate matter visible. This is MGL sample **2017-0017-J3231**
- 2) Discharge from the processing plant that was used in the processing and cleaning of fish. This sample was collected after it had passed over a fine-meshed screen (as per their permit) and prior to discharge out into the environment. This sample was had a cloudy, white appearance, with visible particulate matter. This is MGL sample **2017-0017-J3232**

Note – one additional discharge from this site was unable to be accessed for sampling. The liquid from the processing plant floor is passed over a 6mm screen, and then joins directly into the pipe for discharge.

Laboratory Sample Handling

Samples were collected in new 2L sample bottles, and were transported to the DFO Molecular Genetics Lab on ice and in a locked truck. They arrived at the lab within 3-6 hours of collection.

Samples from the Fish Plant discharge inspections (MGL AQ# 2017-0017) were processed in the Molecular Genetics Forensics Lab at the Pacific Biological station, a laboratory space in the Molecular Genetics Section of DFO Science that is dedicated to highly sensitive and/or legal samples. This room is kept locked at all times, and has extremely limited access to qualified MGL staff. All personnel accessing this lab are required to sign in/out. Samples processed in this lab are either of a legal nature, or are highly sensitive or degraded DNA (e.g. eDNA/Scat samples). Only one sample file/type can be processed at one time in this lab, and the laboratory processing stations are sterilized with bleach and UV between samples. Any processing steps requiring use of equipment outside of this laboratory were carried out with samples constrained to sealed containers (e.g. centrifugation, PCR amplification).

Details of sample processing methodologies are presented in Appendix 1.

Results:

PRV was detected in all samples tested. The number of viruses per mL of water was calculated to allow total viral burden to be assessed based on discharge estimates. Technical controls confirmed that equipment was performing appropriately and results were of high integrity.

Detailed results are presented in Appendix 2A (raw data containing results for all technical replicates) and 2B (synthesized data).

Context:

The high prevalence of PRV in farmed BC Salmon is well documented. The presence of the virus in facility effluent was therefore expected.

References:

Biering E., Garseth A.H. 2012. Heart and Skeletal Muscle Inflammation (HSMI) of farmed Atlantic Salmon (*Salmo salar* L.) and the associated Piscine Reovirus (PRV). In: Feist S, editor. ICES Identification Leaflets for Diseases and Parasites of Fish and Shellfish. Copenhagen: International Council for the Exploration of the Sea; p. 6.

Di Cicco, E., Ferguson, H.W., Schulze, A.D., Kaukinen, K.H., Li, S., Vanderstichel, R., Wessel, O., Rimstad, E., Gardner, I.A., Hammell, K.L., 2017, Heart and skeletal muscle inflammation (HSMI) disease diagnosed on a British Columbia salmon farm through a longitudinal farm study. PLoS ONE 12, 843 e0171471.

Ferguson, H.W., Kongtorp, R.T., Taksdal, T., Graham, D. and Falk, K., 2005. An outbreak of disease resembling heart and skeletal muscle inflammation in Scottish farmed salmon, *Salmo salar* L., with observations on myocardial regeneration. *Journal of fish diseases*, 28(2), pp.119-123.

Finstad, Ø.W., Dahle, M.K., Lindholm, T.H., Nyman, I.B., Løvoll, M., Wallace, C., Olsen, C.M., Storset, A.K. and Rimstad, E., 2014. Piscine orthoreovirus (PRV) infects Atlantic salmon erythrocytes. *Veterinary research*, 45(1), p.35.

Godoy M.G., Kibenge M.J., Wang Y., Suarez R., Leiva C., Vallejos F., Kibenge F.S. 2016. First description of clinical presentation of piscine orthoreovirus (PRV) infections in salmonid aquaculture in Chile and identification of a second genotype (Genotype II) of PRV. *Virology journal* 13(1): p.98.

Hauge H., Vendramin N., Taksdal T., Olsen A.B., Wessel Ø., Mikkelsen S.S., Alencar A.L.F., Olesen N.J., Dahle M.K. 2017. Infection experiments with novel Piscine orthoreovirus from rainbow trout (*Oncorhynchus mykiss*) in salmonids. *PloS one* 12(7), p.e0180293.

Kibenge M.J.T., Iwamoto T., Wang Y., Morton A., Godoy M.G., Kibenge F. 2013. Whole-genome analysis of Piscine Reovirus (PRV) shows PRV represents a new genus in Family Reoviridae and its genome segment S1 sequences group it into two separate sub-genotypes. *Virology Journal* 10:230.

Kongtorp R.T., Taksdal T., Lyngøy A. 2004. Pathology of heart and skeletal muscle inflammation (HSMI) in farmed Atlantic salmon *Salmo salar*. *Diseases of Aquatic Organisms* 59:217-224.

Miller, K.M., Günther, O.P., Li, S., Kaukinen, K.H. and Ming, T.J., 2017. Molecular indices of viral disease development in wild migrating salmon. *Conservation Physiology* 5(1).

Siah A., Morrison D.B., Fringuelli E., Savage P., Richmond Z., Johns R., Purcell M.K., Johnson S.C, Saksida S.M. 2015. Piscine reovirus: Genomic and molecular phylogenetic analysis from farmed and wild salmonids collected on the Canada/US Pacific Coast. *PLoS ONE* 10(11):e0141475.

Takano T., Nawata A., Sakai T., Matsuyama T., Ito T., Kurita J., Terashima S., Yasuike M., Nakamura Y., Fujiwara A., Kumagai A. 2016. Full-Genome sequencing and confirmation of the causative agent of Erythrocytic inclusion body syndrome in Coho Salmon identifies a new type of Piscine Orthoreovirus. *PloS one* 11(10), p.e0165424.

Wessel Ø., Braaen S., Alarcon M., Haatveit H., Roos N., Markussen T., Tengs T., Dahle M.K., Rimstad E. 2017. Infection with purified Piscine orthoreovirus demonstrates a causal relationship with heart and skeletal muscle inflammation in Atlantic salmon. *PloS one* 12(8), p.e0183781.

Responder: XXXX, Science

Responder:

REVIEW INFORMATION

This response does not constitute delivery of peer – reviewed Science advice; it is intended as a rapid response to an immediate requirement for Science input.

Reviewed by: Lesley MacDougall, Coordinator, Centre for Science Advice Pacific Region

Date: XXXX, 2017

Comments:

Approved by:

Date:

Comments:

Burgetz, Ingrid

Subject: Risk Assessment - Path Forward (UPDATED)
Location: 12E238 & Teleconference

Start: Mon 18/12/2017 11:00 AM
End: Mon 18/12/2017 12:00 PM
Show Time As: Tentative

Recurrence: (none)

Meeting Status: Not yet responded

Organizer: Moore, Wayne

Required Attendees: Lowe, Carmel; LaRue, Jean-François; Parsons, Jay; Thomson, Andrew

Optional Attendees: Taylor, Nathan; Caroline Mimeault; Burgetz, Ingrid



MECTS-#378767...



Systemic bacterial
infection w...



Leads for risk
assessments.xls...



Gantt chart
pathogen transf...

Teleconference Dial-In Information

Local dial-in/Numéro de telephone local: (613) 960-7513

Conference ID/Numéro de conférence: [REDACTED]

Toll-free dial-in/ Numéro de telephone sans frais: 1-877-413-4788

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UNCLASSIFIED

2017-007-00933
EKME # 3787671

MEMORANDUM FOR THE DIRECTOR GENERALS OF STRATEGIC AND
REGULATORY SCIENCE, AQUACULTURE MANAGEMENT DIRECTORATE, PACIFIC
REGION SCIENCE, AND PACIFIC FISHERIES MANAGEMENT

**UPDATE ON PATHOGEN TRANSFER RISK ASSESSMENTS
IN THE DISCOVERY ISLANDS IN BRITISH COLUMBIA
(FOR INFORMATION)**

SUMMARY

The purpose of this memo is to update you on the planned next steps for pathogen transfer risk assessments in the Discovery Islands in British Columbia.

Following the successful Canadian Science Advisory Secretariat peer review of the assessment of the risk to Fraser River sockeye salmon due to Infectious Hematopoietic Necrosis Virus transfer from Atlantic salmon farms in the Discovery Islands, the same framework will be applied to assessing the risks associated with other pathogens that have caused disease on Atlantic salmon farms in that area.

Nine pathogens have been identified to potentially undergo formal risk assessments, and in preparation for initiating the next risk assessments, the scientific information on the characteristics of each pathogen is being collated and analyzed. As much of the scientific expertise related to bacterial pathogens resides outside of the department, the timing of the next risk assessments will be dependent on the availability of these external experts. However, in order to meet the government's commitment to respond to the Cohen Commission recommendations, this series of risk assessments, including a synthesis, need to be completed by the end of the 2019/2020 fiscal year.

BACKGROUND

In 2014, Aquaculture Management (NCR and Pacific) requested Canadian Science Advisory Secretariat (CSAS) science advice on the risks of pathogen transfer from Atlantic salmon farms to Pacific salmon in British Columbia. It was then agreed that, as a starting point, the risks to Fraser River sockeye salmon would be undertaken as a priority, consistent with the Cohen commission recommendations. In addition, it was also agreed that advice would be delivered through a series of pathogen-specific risk assessments, followed by a synthesis.

The first pathogen transfer risk assessment conducted under the Aquaculture Science Environmental Risk Assessment Initiative was successfully peer-reviewed through a Canadian Science Advisory Secretariat meeting in December 2016. This first assessment determined the risks to Fraser River sockeye salmon abundance and diversity due to infectious hematopoietic necrosis virus (IHNV) transfer from Atlantic salmon farms located in the Discovery Islands of British Columbia to be minimal. The peer-review process confirmed the risk assessment framework and conceptual model to be appropriate for conducting pathogen transfer risk assessments.

As agreed at the onset of this process, the Aquaculture Regulatory Science group is now planning the next pathogen transfer risk assessments in the Discovery Islands.

STRATEGIC CONSIDERATIONS

The following three criteria have been established to prioritize the next pathogen transfer risk assessments to be conducted in the Discovery Islands area:

1. pathogen(s) cause disease on Atlantic salmon farms in the Discovery Islands;
2. sockeye salmon are susceptible to the disease caused by the pathogen; and
3. there is temporal overlap between disease outbreaks on Atlantic salmon farms and sockeye salmon occurrence in the Discovery Islands.

Evidence that some pathogens caused disease on Atlantic salmon farms in the Discovery Islands (first criteria) was obtained by evaluating data submitted by industry as fish health events and diagnosed at the farm level through fish health audits between 2002 and early 2017. In addition to IHNV for which a pathogen transfer risk assessment has already been completed, the following nine diseases have been reported on Atlantic salmon farms in the Discovery Islands:

- **amoebic gill disease** (AGD) caused by *Neoparamoeba perurans* (protozoa);
- **bacterial kidney disease** (BKD) caused by *Renibacterium salmoninarum* (bacteria);
- **enteric redmouth disease** (ERD) caused by *Yersinia ruckeri* (bacteria);
- **furunculosis** caused by *Aeromonas salmonicida* (bacteria);
- **idiopathic heart disease** of which the cause is unknown;
- **mouth rot** caused by *Tenacibaculum maritimum* (bacteria);
- **salmonid rickettsial septicaemia** (SRS) caused by *Piscirickettsia salmonis* (bacteria);
- **viral hemorrhagic septicaemia** (VHS) caused by the VHS virus; and
- **winter ulcers** caused by *Moritella viscosa* and other bacteria.

.../3

Six out the nine diseases are caused by bacterial pathogens for which there is a lack of expertise within the department. As a result, it will be necessary to engage with external experts to assist with the risk assessments of bacterial pathogens, and the timing of those risk assessments will consequently be dependent on the availability of those experts.

The assessment of the risks related to idiopathic heart disease will incorporate conclusions from recent publications and on-going research on heart and skeletal muscle inflammation (HSMI) and *Piscine orthoreovirus* (PRV).

Other diseases have been detected on Pacific salmon farms within the Discovery Islands, or on Atlantic salmon farms outside of the Discovery Islands, or have been identified to Aquaculture Management Directorate as being of concern to Environmental Non-Government Organizations. These diseases are (1) atypical furunculosis, (2) infectious salmon anemia (ISA), (3) *Microsporidium cerebralis* infection, (4) salmon leukemia and (5) vibriosis. Currently, the pathogens causing those diseases fall outside of the scope of this initiative which is limited to pathogens causing disease on Atlantic salmon farms in the Discovery Islands.

INTERNAL CONSULTATIONS

The above lists were developed in collaboration with Aquaculture Management Directorate during a meeting with Aquaculture Regulatory Science and Aquaculture Management (NCR and Pacific) in Vancouver in May 2017 to discuss the Fish Health Research Plan, which included among other items, status and next steps on pathogen transfer risk assessments in the Discovery Islands.

Aquaculture Management agreed that Aquaculture Regulatory Science would determine the details of how the next risk assessments for the nine remaining pathogens that have caused disease on Atlantic salmon farms in the Discovery Islands will be conducted.

EXTERNAL CONSULTATIONS

The results of the evaluation of pathogens that caused disease on Atlantic salmon farms in the Discovery Islands were confirmed with industry veterinarians. Additionally, an overview of the IHNV risk assessment has been presented to the members of the British Columbia Salmon Farmer Association (BCSFA).

NEXT STEPS

The science advisory report and accompanying research documents from the IHNV risk assessment will be published on the Canadian Science Advisory Secretariat website this fall. A technical briefing with stakeholders is being planned just prior to publication to provide an overview of the risk assessment process and findings, and to discuss the next pathogens that will be addressed.

.../4

Aquaculture Regulatory Science is currently collating information to address the second and third criteria (sockeye salmon susceptibility and temporal overlap) to determine the final list of pathogens to undergo a formal pathogen transfer risk assessment and to identify potential external experts to assist with the risk assessments of bacterial pathogens. The possibility of conducting risk assessments for multiple bacterial pathogens simultaneously is currently under consideration.

The next pathogen transfer risk assessments will be conducted under the same risk assessment framework and will follow the same conceptual model to ensure similarities between assessments and make a synthesis possible. In order to meet the government's commitment to respond to the Cohen Commission recommendations, this series of risk assessments, including the synthesis, need to be completed by the end of the 2019/2020 fiscal year.

Jay Parsons

Director, Aquaculture, Biotechnology and Aquatic Animal Health Science
National Capital Region

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Pathogen Transfer Risk Assessments in the Discovery Islands (bacteria causing systemic infections)

Components	Step	Due By	Completed On	Bacterial Kidney Disease (BKD)	Enteric Redmouth (ERM)	Furunculosis	Salmonid rickettsial septicaemia (SRS)	Notes
Problem formulation	Problem formulation (draft)	10-Nov-17	10-Nov-17	Caroline	Caroline	Caroline	Caroline	
	Meeting with client	10-Nov-17		Jay/Ingrid	Jay/Ingrid	Jay/Ingrid	Jay/Ingrid	
	Engage with CHA	10-Nov-17		Wayne/Jay	Wayne/Jay	Wayne/Jay	Wayne/Jay	
	Working group formation	17-Nov-17		Jay/Ingrid	Jay/Ingrid	Jay/Ingrid	Jay/Ingrid	
	Working group review of problem	30-Nov-17		Ingrid/Caroline	Ingrid/Caroline	Ingrid/Caroline	Ingrid/Caroline	
Communications	Problem formulation (final)	8-Dec-17		Caroline	Caroline	Caroline	Caroline	
	Update industry	TBD	ongoing	Jay/Ingrid	Jay/Ingrid	Jay/Ingrid	Jay/Ingrid	
	Debrief NGOs, First Nations, province	TBD		Jay/Ingrid	Jay/Ingrid	Jay/Ingrid	Jay/Ingrid	
Data	Case definition	18-Oct-17	1-Nov-17	Jay/Ingrid	Jay/Ingrid	Jay/Ingrid	Jay/Ingrid	
	Contact industry	20-Oct-17	2-Nov-17	Jay	Jay	Jay	Jay	
	Industry data acquisition	10-Nov-17		Ingrid/Caroline	Ingrid/Caroline	Ingrid/Caroline	Ingrid/Caroline	
	Industry data analysis	26-Jan-18		Caroline	Caroline	Caroline	Caroline	
Pathogen working paper	Outlines	2-Oct-17	2-Oct-17	Caroline	Caroline	Caroline	Caroline	
	Identification of lead author	2-Oct-18	2-Oct-18	Ingrid/Caroline	Ingrid/Caroline	Ingrid/Caroline	Ingrid/Caroline	
	Pathogen working paper (draft)	12-Jan-18		Linda Rhodes	Joy Wade	France Bolly	Simon Jones	
	Distribution for peer review	4-May-18		Caroline	Caroline	Caroline	Caroline	
	Pathogen working paper (reviewed)			Linda Rhodes	Joy Wade	France Bolly	Simon Jones	
Risk assessment working paper	Pathogen working paper (approval)			Linda Rhodes	Joy Wade	France Bolly	Simon Jones	
	Risk assessment workshop	1-Sep-18		Linda Rhodes	Joy Wade	France Bolly	Simon Jones	
	Risk assessment (draft)	2-Feb-18		Ingrid/Caroline	Ingrid/Caroline	Ingrid/Caroline	Ingrid/Caroline	
	Distribution for peer review	16-Mar-18		Caroline and WG	Caroline and WG	Caroline and WG	Caroline and WG	
	Risk assessment (reviewed)			Caroline and WG	Caroline and WG	Caroline and WG	Caroline and WG	
CSAS peer-review process	Risk assessment (approval)			Caroline and WG	Caroline and WG	Caroline and WG	Caroline and WG	
	Risk assessment (final)	1-Sep-18		Caroline and WG	Caroline and WG	Caroline and WG	Caroline and WG	
	Meeting agenda	4-May-18		Caroline/France	Caroline/France	Caroline/France	Caroline/France	
	Distribution of meeting material	4-May-18		Steering committee	Steering committee	Steering committee	Steering committee	
	Presentation for pathogen paper	15-Jun-18		Linda Rhodes	Joy Wade	France Bolly	Simon Jones	
Deliverables	Presentation for risk assessment	15-Jun-18		Caroline/France	Caroline/France	Caroline/France	Caroline/France	
	CSAS peer-review meeting	15-Jun-18		CSAS meeting chair	CSAS meeting chair	CSAS meeting chair	CSAS meeting chair	
	Reviewed pathogen paper			Linda Rhodes	Joy Wade	France Bolly	Simon Jones	
	Reviewed risk assessment			Caroline	Caroline	Caroline	Caroline	
	Draft SAR			CSAS participants	CSAS participants	CSAS participants	CSAS participants	
Deliverables	Revised SAR			Caroline/France	Caroline/France	Caroline/France	Caroline/France	
	Approval of pathogen paper			CSAS chair	CSAS chair	CSAS chair	CSAS chair	
	Approval of risk assessment			CSAS chair	CSAS chair	CSAS chair	CSAS chair	
	Approval of SAR			CSAS chair	CSAS chair	CSAS chair	CSAS chair	
	Translation of SAR			CSAS office	CSAS office	CSAS office	CSAS office	
	Submission of pathogen paper			Caroline/France	Caroline/France	Caroline/France	Caroline/France	
	Submission of risk assessment	1-Sep-18	1-Sep-18	Jay	Jay	Jay	Jay	
	Submission of SAR (English)	1-Sep-18	1-Sep-18	Jay	Jay	Jay	Jay	
	Submission of SAR (French)			Jay	Jay	Jay	Jay	
				Jay	Jay	Jay	Jay	



CLASSIFICATION
GCCMS #: 2017-007-00933
EKME #: 3787671

To: Wayne Moore
Jean-François LaRue
Pour: Carmel Lowe
Andy Thompson

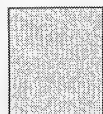
Date: September 22, 2018

Object: **UPDATE ON PATHOGEN TRANSFER RISK ASSESSMENTS**
Objet: **IN THE DISCOVERY ISLANDS IN BRITISH COLUMBIA**

From / Jay Parsons, Director, Aquaculture, Biotechnology and Aquatic Animal Health
De: Science Branch

Via:

Additional approvals:
Autre(s) approbation(s):



Material for the Senior Assistant
Deputy Minister/Documents pour le
Sous-ministre adjoint principal



Your Signature
Votre signature



Information

Screen:
Filtre:

Remarks:
Remarques:

Distribution:

Rédacteur: Caroline Mimeault (991-1439) / Ingrid Burgetz / Jay Parsons / db

Dickie, Catherine

From: Miller-Saunders, Kristi
Sent: December 18, 2017 10:24 AM
To: Lowe, Carmel; Taylor, Nathan
Cc: MacDougall, Lesley
Subject: RE: question re RSR

Make sure the report does not say investigation, but rather inspection. I did not catch this previously.

Thanks
Kristi

From: Lowe, Carmel
Sent: December-18-17 10:04 AM
To: Miller-Saunders, Kristi; Taylor, Nathan
Cc: MacDougall, Lesley
Subject: question re RSR

It is unclear in this sentence whether the virus is found in wild or farmed Coho, Chinook, Rainbow, Steelhead, Sockeye, Chum and Pink.... Can you clarify?

"Farmed and wild Atlantic Salmon (*Salmo salar*), Coho Salmon (*Oncorhynchus kisutch*), Chinook Salmon (*Oncorhynchus tshawytscha*), and Rainbow trout (*Oncorhynchus mykiss*), and wild Cutthroat Trout (*Oncorhynchus clarkii*), Steelhead Trout (*Oncorhynchus mykiss*), Sockeye Salmon (*Oncorhynchus nerka*), Chum Salmon (*Oncorhynchus keta*) and Pink Salmon (*Oncorhynchus gorbuscha*) have all tested positive for PRV through molecular testing."

Carmel

Carmel Lowe, Ph.D.
Regional Director Science | Directrice régionale des sciences
Fisheries and Oceans Canada | Pêches et Océans Canada
Pacific Biological Station | Station biologique du Pacifique
3190 Hammond Bay Rd, Nanaimo, BC, Canada V9T 6N7

Carmel.Lowe@dfo-mpo.gc.ca
Telephone | Téléphone 250-756-7177
Facsimile | Télécopieur 250-729-8360
Government of Canada | Gouvernement du Canada

Dickie, Catherine

From: Lowe, Carmel
Sent: December 18, 2017 10:28 AM
To: Miller-Saunders, Kristi; Taylor, Nathan
Cc: MacDougall, Lesley
Subject: RE: question re RSR

Ok perfect.

Carmel

Carmel Lowe, Ph.D.
Regional Director Science | Directrice régionale des sciences
Fisheries and Oceans Canada | Pêches et Océans Canada
Pacific Biological Station | Station biologique du Pacifique
3190 Hammond Bay Rd, Nanaimo, BC, Canada V9T 6N7

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Telephone | Téléphone 250-756-7177
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Government of Canada | Gouvernement du Canada

From: Miller-Saunders, Kristi
Sent: Monday, December 18, 2017 10:23 AM
To: Lowe, Carmel <Carmel.Lowe@dfo-mpo.gc.ca>; Taylor, Nathan <Nathan.Taylor@dfo-mpo.gc.ca>
Cc: MacDougall, Lesley <Lesley.MacDougall@dfo-mpo.gc.ca>
Subject: RE: question re RSR

It is found in farmed and wild Atlantic, Coho, Chinook salmon and Rainbow trout, and the remaining species only tested in wild as they are not farmed

From: Lowe, Carmel
Sent: December-18-17 10:04 AM
To: Miller-Saunders, Kristi; Taylor, Nathan
Cc: MacDougall, Lesley
Subject: question re RSR

It is unclear in this sentence whether the virus is found in wild or farmed Coho, Chinook, Rainbow, Steelhead, Sockeye, Chum and Pink.... Can you clarify?

"Farmed and wild Atlantic Salmon (*Salmo salar*), Coho Salmon (*Oncorhynchus kisutch*), Chinook Salmon (*Oncorhynchus tshawytscha*), and Rainbow trout (*Oncorhynchus mykiss*), and wild Cutthroat Trout (*Oncorhynchus clarkii*), Steelhead Trout (*Oncorhynchus mykiss*), Sockeye Salmon (*Oncorhynchus nerka*), Chum Salmon (*Oncorhynchus keta*) and Pink Salmon (*Oncorhynchus gorbuscha*) have all tested positive for PRV through molecular testing."

Carmel

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Government of Canada | Gouvernement du Canada

Ryan, Patricia

From: Moore, Wayne
Sent: December-18-17 3:18 PM
To: Parsons, Jay
Subject: Fw: Rapid Science Response.
Attachments: RSR2017_AQU01_Browns_and_TofinoPRV_Final_for_APPROVAL.DOCX; Appendix 1.docx; Appendix 2A.xlsx; Appendix 2B.xlsx

Categories: ATIP

Sent from my BlackBerry 10 smartphone on the Rogers network.

From: Lowe, Carmel <Carmel.Lowe@dfo-mpo.gc.ca>
Sent: Monday, December 18, 2017 1:20 PM
To: McPherson, Arran
Cc: Moore, Wayne; MacDougall, Lesley
Subject: Rapid Science Response.

Please find attached the rapid science response which I have just approved.

Carmel

Carmel Lowe, Ph.D.
Regional Director Science | Directrice régionale des sciences
Fisheries and Oceans Canada | Pêches et Océans Canada
Pacific Biological Station | Station biologique du Pacifique
3190 Hammond Bay Rd, Nanaimo, BC, Canada V9T 6N7
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Government of Canada | Gouvernement du Canada

Centre for Science Advice Pacific

FPP non-CSAS Request for Rapid Science Response

Request Contact:	Kristi Miller Saunders	Project Type: Aquaculture-Emergency response
Date of request:	November 29, 2017	Project footprint:
Region of proposed impact:	Tofino and Browns Bay, British Columbia	Habitat Type: Coastal
Purpose of request:	Information for Ministry of Environment / Environment and Climate Change Canada investigation	
Potential affected species:	Pacific salmon	
Date required:	December 15, 2017	Request #:2017AQU01
Timeline rationale:	Required for ongoing inspection of fish processing facilities as conducted by Province of BC	

PROJECT OVERVIEW

In Canada, the regulation of processing of fish products is a shared Provincial – Federal responsibility. BC Ministry of Environment & Climate Change Strategies (ENV) supports marine fisheries and aquaculture and seafood industry development, issuing licenses to businesses involved in the aquaculture sector - including permits for seafood processing facilities - under the BC *Fisheries Act and Fish Inspection Act*. Thus, as a function of normally-operating fish processing plants, fish waste effluent is released back into the marine ecosystem subject to conditions of license.

Environment and Climate Change Canada (ECCC) administers section 36 of DFO's *Fisheries Act*, the key pollution prevention provision, prohibiting the deposit of deleterious substances into waters frequented by fish, unless authorized by regulations under the *Fisheries Act* or other federal legislation. A deleterious substance can be any substance that, if added to any water, would degrade or alter its quality such that it could be harmful to fish, fish habitat or the use of fish by people.

Following the public release of a video showing fish waste effluent being released into the marine environment, and subsequent related news articles and public interest, ENV initiated an inspection of two fish processing plants that were the subject of the videos. ENV has also initiated a compliance audit for fish processing plants.

The BC Ministry of Environment & Climate Change Strategies (ENV), Environmental Protection Regional Operations Branch requested assistance from DFO to support the collection of water samples at two fish processing facilities and to test collected effluent for the presence of the Piscine OrthoReovirus (PRV), as part of the ongoing inspection. Other labs contacted at the time did not have the capacity to perform the necessary diagnostics on water samples.

1ST QUESTION

Background:

Piscine OrthoReovirus (PRV) is known to be present in Norway, Japan, the United Kingdom, Ireland, Chile, the United States and Canada (Biering and Garseth 2012; Kibenge et al. 2013; Siah et al. 2015). Farmed and wild Atlantic Salmon (*Salmo salar*), Coho Salmon (*Oncorhynchus kisutch*), Chinook Salmon (*Oncorhynchus tshawytscha*), and Rainbow trout (*Oncorhynchus mykiss*), and wild Cutthroat Trout (*Oncorhynchus clarkii*), Steelhead Trout (*Oncorhynchus mykiss*),

**Pages 1845 to / à 1855
are withheld pursuant to section
sont retenues en vertu de l'article**

68(a)

**of the Access to Information Act
de la Loi sur l'accès à l'information**

Parsons, Jay

From: Taylor, Nathan
Sent: Monday, December 18, 2017 6:10 PM
To: Parsons, Jay
Cc: McLeod, Patricia
Subject: [REDACTED]

If you've got 30 mins to call and discuss, we should.

Trish – could I prevail on you to set something up please?

Best

NG

From: Townsend, Jill
Sent: Friday, December 15, 2017 5:19 PM
To: Taylor, Nathan
Cc: Lowe, Carmel
Subject: [REDACTED]
[REDACTED]

Nathan,

[REDACTED]

Jill Townsend

Litigation Case Manager, Litigation Unit, Fisheries & Oceans Canada | Pêches et Océans Canada, Pacific Regional Office | Région du Pacifique, 200-401 Burrard Street | 401 rue Burrard, Pièce 200, Vancouver, BC V6C 3S4, Jill.Townsend@dfo-mpo.gc.ca Telephone | Téléphone (604) 658-2843, Cell | [REDACTED] Government of Canada | Gouvernement du Canada

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s.16(2)(c)

s.21(1)(a)

s.21(1)(b)

s.23

From: Bartlett, Michael
Sent: December-15-17 10:59 AM
To: Townsend, Jill; Ikejiani, Alexander
Subject: [REDACTED]
[REDACTED]

Hi Jill:

[REDACTED]

[REDACTED]

Michael K. Bartlett
Legal Counsel
DFO-Legal Services
T:(613) 993-5791
B:([REDACTED])

From: Townsend, Jill
Sent: November-24-17 11:56 AM
To: Ikejiani, Alexander; Bartlett, Michael
Subject: [REDACTED]
[REDACTED]

Thanks Alex, and Michael.

Sent from my BlackBerry 10 smartphone on the Bell network.

From: Ikejiani, Alexander
Sent: Friday, November 24, 2017 8:42 AM
To: Townsend, Jill; Bartlett, Michael
Subject: [REDACTED]
[REDACTED]

Hello Jill,

[REDACTED]

Regards

Alex Ikejiani
Legal Counsel
Department of Justice
200 Kent Street
Ottawa ON K1A 0E6
Tel: (613) 991-6230
Email: alexander.ikejiani@dfo-mpo.gc.ca

Certified Specialist in Environmental Law

s.16(2)(c)

s.23

From: Townsend, Jill
Sent: November-23-17 10:32 PM
To: Ikejiani, Alexander
Subject: [REDACTED]
[REDACTED]

Alex,

Jill Townsend

Litigation Case Manager, Litigation Unit, Fisheries & Oceans Canada | Pêches et Océans Canada, Pacific Regional Office | Région du Pacifique, 200-401 Burrard Street | 401 rue Burrard, Pièce 200, Vancouver, BC V6C 3S4, Jill.Townsend@dfo-mpo.gc.ca Telephone | Téléphone (604) 658-2843, Cell | [REDACTED] Government of Canada | Gouvernement du Canada

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From: Townsend, Jill
Sent: November-23-17 7:07 PM
To: Taylor, Nathan
Cc: Lowe, Carmel
Subject: [REDACTED]

Hello Nathan,

Jill Townsend

Litigation Case Manager, Litigation Unit, Fisheries & Oceans Canada | Pêches et Océans Canada, Pacific Regional Office | Région du Pacifique, 200-401 Burrard Street | 401 rue Burrard, Pièce 200, Vancouver, BC V6C 3S4, Jill.Townsend@dfo-mpo.gc.ca Telephone | Téléphone (604) 658-2843, Cell | [REDACTED] Government of Canada | Gouvernement du Canada

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From: Taylor, Nathan
Sent: November-22-17 4:44 PM
To: Townsend, Jill
Cc: Lowe, Carmel
Subject: [REDACTED]

s.16(2)(c)

s.21(1)(a)

s.21(1)(b)

s.23

Hi Jill,



Best regards,

s.23

Nathan

Nathan G. Taylor, Ph.D.

Division Manager | Directeur de secteur

Aquatic Diagnostics Genomics and Technology Division | Division des diagnostics, la génomique, de la technologie
aquatique

Fisheries and Oceans Canada | Pêches et Océans Canada

Miller-Saunders, Kristi

From: Miller-Saunders, Kristi
Sent: December-19-17 2:11 PM
To: Thomson, Andrew
Subject: Talk I gave to Industry
Attachments: BCSFA_Jaundice Talk KM-ED Nov 28, 2017_Shortened-Comp.pptx

Andrew,

Enclosed is the talk I gave at a BC Salmon Farmers Association meeting on PRV-HSMI state of knowledge workshop December 4th- 5th attended by Norwegian scientists, industry vets and leaders, BC and US Scientists, and DFO regulators. The talk outlines the most recent research out of my lab on PRV and linkages with disease in Pacific salmon. Key points are:

We have demonstrated that PRV infections in Chinook salmon can induce a host response that we have shown previously to be diagnostic of the presence of viral disease. This work was published in Conservation Physiology this year.

We demonstrate that 14% of moribund/dead farmed Chinook salmon on the west coast obtained through the DFO audit program were diagnosed with jaundice/anemia, a disease that around the world has been associated with various strains of PRV. There is only a single strain of PRV in BC, that which is known to cause HSMI in Atlantic salmon.

We show that throughout the developmental pathway of jaundice and across multiple affected tissues, PRV is localized within the regions and cells that become diseased, whether disease is through cell death (necrosis) in liver and kidney or inflammation in heart. We gave a similar talk on HSMI in Atlantic salmon and also demonstrated PRV localized with inflammatory lesions in heart and skeletal muscle tissue.

The primary infective tissue for PRV in both species is the red blood cells (which is why blood water from farmed fish is potentially a strong risk for PRV transmission to wild fish). We show that while PRV remains exclusively in the blood, even at high levels, it is tolerated and there is no disease response in the host. When the virus leaves the blood cells to infect other tissues/cells, it induces a disease response in the host.

The difference between HSMI in Atlantic salmon and jaundice/anemia in Chinook salmon is that in HSMI, PRV appears to leave the red blood cells without lysing (rupturing) them, whereas in Chinook salmon, there is massive lysis of red blood cells leading to anemia (pale gills and tissues) and overloading the kidney and liver with Heme from the breakdown of hemoglobin. Heme is processed in kidney and liver, but becomes toxic at high levels, leading to necrosis (death) of kidney tubules and hematocytes (liver cells), and a jaundice (yellowing) appearance in the fish. While we show that the virus also directly infects these cells, we suspect the heme overload, caused by PRV lysis of red blood cells, is likely the main mechanism leading to disease in jaundice fish. Liver and kidney are not highly affected in HSMI in Atlantic salmon, as the virus goes on to infect muscle cells (heart and skeletal) causing inflammation. This inflammatory response is present, but much reduced and very transient in Chinook salmon with jaundice. In fact the heart inflammation all bit disappears by the time the kidney becomes neurotic.

We have also demonstrated early (jaundice) disease development in wild Chinook salmon. There was a presentation by Dr. Maureen Purcell at the same meeting that showed an association of the same strain of PRV with a similar disease, which they and the Japanese call EIBS, in Washington State Coho salmon.

Kristi

Head, Molecular Genetics

Pacific Biological Station

**Pages 1863 to / à 1894
are duplicates of
sont des duplicatas des
pages 1714 to / à 1745**

Miller-Saunders, Kristi

From: Miller-Saunders, Kristi
Sent: December-19-17 3:34 PM
To: Thomson, Andrew
Subject: RE: Rapid Science Response - aquaculture fish processing effluent testing

I am still coming down the hill from the upper levels highway. How late will be in the office? If I am late, can we meet somewhere near by or do you need to get on the road right away?
Kristi

From: Thomson, Andrew
Sent: December 19, 2017 2:28 PM
To: Miller-Saunders, Kristi
Subject: RE: Rapid Science Response - aquaculture fish processing effluent testing

That works fine.

Andrew J L Thomson
Regional Director | Directeur Régionale Fisheries Management Branch | Direction de la gestion des pêches

-----Original Message-----

From: Miller-Saunders, Kristi
Sent: Tuesday, December 19, 2017 2:16 PM
To: Thomson, Andrew <Andrew.Thomson@dfo-mpo.gc.ca>
Subject: RE: Rapid Science Response - aquaculture fish processing effluent testing

Ok
I [REDACTED] can walk down around 330 if that works. Of course timing depends on traffic. I would like to go over our latest findings with you.

Kristi

From: Thomson, Andrew
Sent: December 19, 2017 2:12 PM
To: Miller-Saunders, Kristi
Subject: Re: Rapid Science Response - aquaculture fish processing effluent testing

I can meet you this afternoon if you want to come to the office.

Andrew J L Thomson

Regional Director | Directeur Régionale Fisheries Management Branch | Direction de la gestion des pêches Pacific Region | Region du Pacifique Fisheries & Oceans Canada | Pêches et Océans Canada

Suite 200 – 401 Burrard St.
Vancouver, BC, Canada V6C 3S4

s.19(1)

andrew.thomson@dfo-mpo.gc.ca
Telephone | Téléphone 604.666.0751
Facsimile | Télécopieur 250.666.8069
Government of Canada | Gouvernement du Canada.
Original Message
From: Miller-Saunders, Kristi
Sent: Tuesday, December 19, 2017 2:11 PM
To: Thomson, Andrew
Subject: RE: Rapid Science Response - aquaculture fish processing effluent testing

From: Thomson, Andrew
Sent: December 19, 2017 1:59 PM
To: Miller-Saunders, Kristi
Subject: Re: Rapid Science Response - aquaculture fish processing effluent testing

What time are you in Vancouver?

Andrew J L Thomson

Regional Director | Directeur Régionale Fisheries Management Branch | Direction de la gestion des pêches Pacific Region | Region du Pacifique Fisheries & Oceans Canada | Pêches et Océans Canada

Suite 200 – 401 Burrard St.
Vancouver, BC, Canada V6C 3S4
andrew.thomson@dfo-mpo.gc.ca
Telephone | Téléphone 604.666.0751
Facsimile | Télécopieur 250.666.8069
Government of Canada | Gouvernement du Canada.
Original Message
From: Miller-Saunders, Kristi
Sent: Tuesday, December 19, 2017 1:54 PM
To: Thomson, Andrew
Cc: Lowe, Carmel
Subject: RE: Rapid Science Response - aquaculture fish processing effluent testing

Hello Andrew,

I sent Amy Tabata to do the sampling with the inspectors from the other agencies and they noted that there was no chemical treatment in either facility and from what Amy was told it was not a requirement of their license. Interestingly I was at an industry meeting when the bloodwater story broke and [REDACTED] said that marine harvest does chlorinate their effluent but others do not necessarily. If there was enough chlorination to kill the virus it would likely also degrade the DNA but given the amount of organic material in their crudely filtered bloodwater it would be doubtful that chlorination alone could kill virus. You are correct in questioning whether or not PCR alone could ascertain whether the virus is still viable. I told them that this could be questioned if samples were chemically treated hence we froze several samples for future infectivity testing just in case. However given lack of treatment and the known robustness of this virus I don't see any reason to suggest the virus would not be viable.

I [REDACTED] will be in Vancouver this afternoon if you want to get together.

Kristi

From: Thomson, Andrew
Sent: December 19, 2017 1:22 PM
To: Miller-Saunders, Kristi
Cc: Lowe, Carmel
Subject: FW: Rapid Science Response - aquaculture fish processing effluent testing

Kristi

- 1) [REDACTED] I'm around this week if you want to pick a time to talk.
- 2) On this rapid science advice, it doesn't appear there was any form of secondary effluent treatment or chlorine treatment at these facilities. However I'm curious that if there was a secondary treatment or some form of chlorine treatment that deactivated the virus, would the PCR test still show positive?

Andrew J L Thomson
Regional Director | Directeur Régionale Fisheries Management Branch | Direction de la gestion des pêches

From: Trudeau, Miriam
Sent: Tuesday, December 19, 2017 12:49 PM
To: Thomson, Andrew <Andrew.Thomson@dfo-mpo.gc.ca>; Antcliffe, Bonnie <Bonnie.Antcliffe@dfo-mpo.gc.ca>
Cc: Kaba, Kyle <Kyle.Kaba@dfo-mpo.gc.ca>
Subject: FW: Rapid Science Response - aquaculture fish processing effluent testing

Not sure if you received these.

From: McPherson, Arran
Sent: Tuesday, December 19, 2017 12:28 PM
To: Trudeau, Miriam <Miriam.Trudeau@dfo-mpo.gc.ca<mailto:Miriam.Trudeau@dfo-mpo.gc.ca>>
Cc: Hopkins, Lillian <Lillian.Hopkins@dfo-mpo.gc.ca<mailto:Lillian.Hopkins@dfo-mpo.gc.ca>>; Jenkins, Phil <Phil.Jenkins@dfo-mpo.gc.ca<mailto:Phil.Jenkins@dfo-mpo.gc.ca>>; White, Andrea <Andrea.White@dfo-mpo.gc.ca<mailto:Andrea.White@dfo-mpo.gc.ca>>
Subject: Rapid Science Response - aquaculture fish processing effluent testing

Miriam, I believe MINO was advised that DFO Science was doing some testing of aquaculture fish processing plant effluent at the request of the province of BC.

To close the loop, the results are enclosed and have been (or very shortly will be) provided to the province. In general, the results are that PRV was detected in the samples. However, given the prevalence of PRV in farmed populations and presence of the virus in blood, it was expected that blood effluent from processing plants would contain PRV.

Arran.

Ryan, Patricia

From: Moore, Wayne
Sent: December-19-17 6:02 PM
To: Parsons, Jay
Subject: Fw: HEAD's UP : Interview request (Pacific region) - The Tyee - aquaculture/PRV

Importance: High

Categories: ATIP

!

Sent from my BlackBerry 10 smartphone on the Rogers network.

From: Smith, Kathleen <Kathleen.Smith@dfp-mpo.gc.ca>
Sent: Tuesday, December 19, 2017 4:50 PM
To: LaRue, Jean-François; Moore, Wayne; McPherson, Arran; Morel, Philippe
Cc: Jenkins, Phil; Nielsen, Ingrid; Fagan, Ashley
Subject: Fw: HEAD's UP : Interview request (Pacific region) - The Tyee - aquaculture/PRV

Pls see below.

From: Saindon, Carole <Carole.Saindon@dfp-mpo.gc.ca>
Sent: Tuesday, December 19, 2017 4:47 PM
To: Gareau, Laura; Lavigne, Kevin
Cc: MacNeil, Vince; Amlani, Ashraf; Hopkins, Lillian; Malko, Carol; Quinn, Caroline; Trudeau, Miriam; Hubley, Marian; Nielsen, Ingrid; Jenkins, Phil; Smith, Kathleen; Fagan, Ashley; Bate, Dan; Rainer, Michelle; Chow, Vance; Gilbert, Sarah; NCR Media RCN (DFO/MPO)
Subject: HEAD's UP : Interview request (Pacific region) - The Tyee - aquaculture/PRV

HEAD's up Laura :

Issue: Reporter [REDACTED] The Tyee [REDACTED] has written to Dr. Ian Keith, Field Operations Vet, DFO Aquaculture Management Division with questions based on his opinion that processing plants and hatcheries are point sources for PRV.

Pacific Communications has received a copy of the reporter's questions, for information. The reporter is hoping to hear back directly from Dr. Keith for a science based interview.

Questions:

1. In November, 2016, you wrote to a colleague: "Processing plants and hatcheries are point sources for PRV. If there is to [be] sustainable aquaculture the processing plants must treat effluent, and keep any infectious disease out, respectively...If enhancement hatcheries are exempt, this is 19th century thinking." Has any action been taken by DFO or any other entity to your knowledge since that time to address these concerns? Do you remain concerned about processing plants and hatcheries as point sources for PRV?
2. What is the nature of these concerns for you? In other words, what is the consequence of additional sources for PRV? Are you concerned about the potential effect of the virus on wild salmon? Please feel free to address both

hatcheries and processing plants separately (i.e. what are your specific concerns with respect to the transfer of hatchery smolts with PRV into salmon farm pens and what are your concerns with respect to PRV-contaminated blood water being discharged into the marine environment)

3. Recent news reports indicated Minister LeBlanc was launching a review in the wake of media attention on blood water discharge from two farmed fish processing plants. Are you involved in this investigation and can you provide me with any details on the investigation?
4. Can you explain your relationship with BC's Animal Health Centre? I understand they audit fish health at salmon farms under some form of agreement with DFO. Do you, as a DFO veterinarian, provide any oversight to their work? How might you typically engage with them as they conduct their work with regards to farmed fish?
5. The recent (2017) Wessel paper in PLOS One established an etiological link between PRV and HSMI - do you accept that PRV causes HSMI and to what degree or under what circumstances would you accept that this is the case?

Ryan, Patricia

From: Moore, Wayne
Sent: December-20-17 10:22 AM
To: Parsons, Jay
Cc: Taylor, Nathan
Subject: [REDACTED]
privileged solicitor client
Attachments: [REDACTED]
Importance: High

For info and sharing with regional colleagues who may not have it.

From: McPherson, Arran
Sent: December 20, 2017 9:54 AM
To: Moore, Wayne <Wayne.Moore@dfo-mpo.gc.ca>
Subject: FW: [REDACTED] - privileged solicitor client
Importance: High

From: Trudeau, Miriam
Sent: Wednesday, December 20, 2017 9:49 AM
To: McPherson, Arran <Arran.McPherson@dfo-mpo.gc.ca>; Sharzer, Stephen <Stephen.Sharzer@dfo-mpo.gc.ca>; Antcliffe, Bonnie <Bonnie.Antcliffe@dfo-mpo.gc.ca>; Thomson, Andrew <Andrew.Thomson@dfo-mpo.gc.ca>; Morel, Philippe <Philippe.Morel@dfo-mpo.gc.ca>
Cc: Hopkins, Lillian <Lillian.Hopkins@dfo-mpo.gc.ca>; Butcher, Ashley <Ashley.Butcher@dfo-mpo.gc.ca>; Malko, Carol <Carol.Malko@dfo-mpo.gc.ca>; Jarjour, Jasmine <Jasmine.Jarjour@dfo-mpo.gc.ca>
Subject: FW: [REDACTED] - privileged solicitor client
Importance: High

[REDACTED]

Miriam

From: Valerio, Michael
Sent: Wednesday, December 20, 2017 7:31 AM
To: Trudeau, Miriam <Miriam.Trudeau@dfo-mpo.gc.ca>
Cc: Cocking, Marie <Marie.Cocking@dfo-mpo.gc.ca>; XNCR-Grp, CA / AC <XNCR-GrpCA/AC@dfo-mpo.gc.ca>; Boudreau-Brown, Nadine <Nadine.Boudreau-Brown@dfo-mpo.gc.ca>; Ménard, Angèle <Angele.Menard@dfo-mpo.gc.ca>; Fadden, Darlene <Darlene.Fadden@dfo-mpo.gc.ca>; Hubley, Marian <Marian.Hubley@dfo-mpo.gc.ca>
Subject: Fw: [REDACTED] - privileged solicitor client

Hi Miriam,

I'm flagging this correspondence sent by Pacific last night. [REDACTED]
will input into system. [REDACTED]

MCU

s.19(1)
s.21(1)(a)
s.21(1)(b)
s.23

The technical briefing today may have some helpful lines [REDACTED] Marian, who in Comms is attending the technical briefing? I can follow up with them.

Thanks,

Sent from my BlackBerry 10 smartphone on the Rogers network.

From: pac.prmc / pac.urpcm (DFO/MPO) <XPAC.PRMCU@dfo-mpo.gc.ca>
Sent: Tuesday, December 19, 2017 9:15 PM
To: Minister / Ministre (DFO/MPO)
Cc: Valerio, Michael
Subject: FW: [REDACTED] privileged solicitor client

The attached was forwarded to me [REDACTED] I note that it is not yet in GCCMS.

From: Townsend, Jill
Sent: Tuesday, December 19, 2017 5:38 PM
To: pac.prmc / pac.urpcm (DFO/MPO)
Subject: [REDACTED] - privileged solicitor client

Hi,

Have you seen the attached yet? Or, started a draft reply for DFO to the attached yet? I am sending this fyi – and to see if we can expect a draft soon [REDACTED] I am not trying to enter this into the system – just an info enquiry here. I'm sure it will make its way to you, [REDACTED]

Jill Townsend

Litigation Case Manager, Litigation Unit, Fisheries & Oceans Canada | Pêches et Océans Canada, Pacific Regional Office | Région du Pacifique, 200-401 Burrard Street | 401 rue Burrard, Pièce 200, Vancouver, BC V6C 3S4, Jill.Townsend@dfo-mpo.gc.ca Telephone | Téléphone (604) 658-2843, Cell | [REDACTED] Government of Canada | Gouvernement du Canada

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From: pac.prmc / pac.urpcm (DFO/MPO)
Sent: December-19-17 5:15 PM
To: Townsend, Jill
Subject: [REDACTED]

Thanks. I'll add that.

From: Townsend, Jill
Sent: Tuesday, December 19, 2017 4:43 PM
To: pac.prmc / pac.urpcm (DFO/MPO)
Cc: Ikejiani, Alexander
Subject: [REDACTED]
Importance: High

s.16(2)(c)

s.21(1)(a)

s.21(1)(b)

s.23

Hello Candace,

[REDACTED]

I was concerned that our draft reply had no response [REDACTED]

[REDACTED] – so I myself prefer including the additional reply noted above in yellow highlighting, perhaps prefaced by something like, “In response to the concerns you’ve raised [REDACTED]

[REDACTED]

Jill Townsend

Litigation Case Manager, Litigation Unit, Fisheries & Oceans Canada | Pêches et Océans Canada, Pacific Regional Office | Région du Pacifique, 200-401 Burrard Street | 401 rue Burrard, Pièce 200, Vancouver, BC V6C 3S4, Jill.Townsend@dfo-mpo.gc.ca Telephone | Téléphone (604) 658-2843, Cell | [REDACTED], Government of Canada | Gouvernement du Canada

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From: pac.prmc / pac.urpcm (DFO/MPO)

Sent: December-19-17 3:18 PM

To: Townsend, Jill

Subject: [REDACTED]

Hi Jill

[REDACTED] Is there a particular person who needs to see it?

Thanks

Candace.

From: Townsend, Jill

Sent: Tuesday, December 19, 2017 2:38 PM

To: pac.prmc / pac.urpcm (DFO/MPO)

Cc: Russow, Theona

Subject: [REDACTED]

Importance: High

Hello, I am following up on the below. [REDACTED]

Jill Townsend

Litigation Case Manager, Litigation Unit, Fisheries & Oceans Canada | Pêches et Océans Canada, Pacific Regional Office | Région du Pacifique, 200-401 Burrard Street | 401 rue Burrard, Pièce 200, Vancouver, BC V6C 3S4, Jill.Townsend@dfo-mpo.gc.ca Telephone | Téléphone (604) 658-2843, Cell | [REDACTED], Government of Canada | Gouvernement du Canada

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s.16(2)(c)

s.21(1)(a)

s.21(1)(b)

s.23

From: Russow, Theona
Sent: December-18-17 3:25 PM
To: Townsend, Jill
Subject: [REDACTED]
Importance: High

And this one.

Thanks,
Theona

Theona Russow | Litigation Manager | Fisheries & Oceans Canada | Pêches et Océans Canada | Pacific Regional Office | Région du Pacifique | 200- 401 Burrard Street | 401 rue Burrard, Pièce 200 | Vancouver, BC V6C 3S4 | Theona.Russow@dfo-mpo.gc.ca | Telephone | Téléphone (604) 666-0776 | Cell [REDACTED] | Government of Canada | Gouvernement du Canada

****SOLICITOR CLIENT PRIVILEGE NOTICE (EMAIL AT THE REQUEST OF COUNSEL):** This email has been prepared at the request of counsel and the contents of this email are subject to solicitor client privilege. Any use, disclosure or copying of the information is strictly prohibited.**

From: pac.prmc / pac.urpcm (DFO/MPO)
Sent: December-18-17 3:23 PM
To: Russow, Theona
Cc: Keefe, Marisa
Subject: ** [REDACTED]
Importance: High

Hi Theona:

(NOTE: I have sent it to AQ to review at the same time; I don't anticipate changes there as it's mostly approved text.)

Please use track changes to insert any necessary edits in the attached document, and FORWARD the document to XPAC PRMCU.

Your review should also include technical accuracy and consistency with policy direction.

Thanks,
Candace

****Please direct all e-mails regarding Minister's (001) and RDG's (501) correspondence to XPAC PRMCU.****

Candace McGuire, Heather Fowlie & Allison Murray

Managers, Pacific Region Ministerial Correspondence Unit
Fisheries and Oceans Canada/Government of Canada
XPACPRMCU@dfo-mpo.gc.ca Tel 604-666-0823

s.16(2)(c)

s.21(1)(a)

s.21(1)(b)

s.23

Gestionnaires de la correspondance ministériel
Pêches et Océans Canada/Gouvernement du Canada
XPACPRMCU@dfo-mpo.gc.ca Tel 604-666-0823

**Pages 1904 to / à 1911
are withheld pursuant to sections
sont retenues en vertu des articles**

21(1)(b), 23, 21(1)(a)

**of the Access to Information Act
de la Loi sur l'accès à l'information**

Mimeault, Caroline

From: Mimeault, Caroline
Sent: December 21, 2017 1:00 PM
To: Parsons, Jay; Garver, Kyle
Subject: Draft answer to media request
Attachments: MECTS-#3863619-v1-2017
_SRS_ABAHS_-_Answers_to_media_request_(The_National_Observer).DOCX

Importance: High

First draft. Please have a look.

Kyle – especially the 2nd and 4th question.

Answers from the 5th question came from previous briefings.

Answers for Media Request

Reporter, The National Observer

December 20th, 2017

-- "the likelihood for juvenile Fraser River Sockeye Salmon to be infected and become diseased due to IHN released from Atlantic Salmon farms is estimated to be extremely unlikely with reasonable uncertainty given current health management practices (i.e., vaccination, surveillance for early detection and depopulation) that limit the amount of potential IHN shed into the environment from infected farms."

DFO is reasonably uncertain that it is extremely unlikely? Is there a way someone could reword this so I understand what that means? Much appreciated.

There were several steps in the likelihood assessment. For each step, the likelihood and the uncertainty were reported separately. The uncertainty is due to both the natural variability of biological systems as well as knowledge gaps in the scientific literature. Where there were knowledge gaps, expert opinion and models were used, and the uncertainty reported reflects how much each step was based on scientific information, models or expert opinion.

Based on available data, it was concluded that it is extremely unlikely for wild fish to get infected by IHN released from the farms as the estimated maximum concentrations would be 7,000 to 100,000 times lower than the concentrations required for infecting juvenile sockeye salmon.

However, given some knowledge gaps related to the IHN concentrations on farms during an outbreak which was estimated through modeling and knowledge gaps related to the time juvenile sockeye salmon spend in net pens and the outcome of a prolonged exposure of juvenile Sockeye Salmon to sublethal doses which was addressed through expert opinion, the conclusion for this specific step were determined to be reasonably uncertain.

However, and most importantly, despite high uncertainties in some area of the risk assessment, there is minimal risk to Fraser River sockeye salmon mainly because it is very unlikely that an IHN outbreak on Atlantic salmon farms in the Discovery Islands would occur given that there has been no IHN outbreak on Atlantic salmon farms in the Discovery Islands since 2003 and given the current effective fish health management practices in place which includes vaccination of all farmed Atlantic salmon against IHN.

-- Will DFO produce similar reports for IHN and the likelihood of infection for other wild Pacific salmon populations? Why or why not?

At this point in time, there are no plans to produce a similar report on IHN in other Pacific salmon. The next pathogen transfer risk assessments will continue to focus on the risk to Fraser River sockeye salmon resulting from pathogens that caused diseases on Atlantic salmon in the Discovery Islands.

However, although the risk assessment focused on the risk to Fraser River sockeye salmon, considerations were given to other fish species susceptible to IHN. Given that other Pacific salmon species are either less susceptible to IHN than sockeye salmon or even not susceptible to this disease, it had no impact on the outcome of the risk assessment.

-- In its section on assumptions, DFO says it assumes all regulations, prevention measures, and vaccination rules are being followed by Atlantic salmon farmers when it comes to IHN. Did it take any steps to verify this?

Regulations and licence conditions include the requirement for a Salmonid Health Management Plan and accompanying proprietary Standard Operating Procedures which are reviewed and approved by DFO as a part of the initial licence application. Additionally, DFO conducts audits of farms under the Fish Health Audit and Surveillance Program on a regular basis. During the audits, the activities, protocols and procedures are reviewed and fish sample are collected for histopathology, bacteriology, virology and molecular diagnostics. A summary of the audit results are available on the DFO website.

It is in the interest of the company to ensure the health of farmed fish. To that end, in addition to conditions of licence, Atlantic salmon companies operating in the Discovery Islands developed and agreed to a Salmon Farming Industry Viral Disease Management Plan which includes the vaccination of all farmed Atlantic salmon against IHN and procedures to respond to an incidence. Additionally, all active Atlantic salmon farms in the Discovery Islands are certified by third parties that require that all fish be vaccinated against diseases for which effective vaccines are available.

-- When was the last time IHN was detected in Pacific salmon, which kind of salmon, and in what kind of numbers? (ie: how bad was the problem?)

IHN is endemic to the Pacific Northwest, meaning it is native to the environment.

Long-term monitoring of British Columbia sockeye salmon stocks from the Skeena, Fraser, and Columbia River watersheds conducted by DFO revealed that annual prevalence of IHN in spawning adult sockeye salmon highly variable within and among stocks. For example, between 1987 and 2015, prevalence of IHN in spawning adults varied from 0 to 50% (average of 9%) in Weaver Creek and from 0 to 62% (average of 11%) in Nadina River.

Prevalence of IHN in juvenile Fraser River sockeye salmon collected by DFO during surveys conducted in the Strait of Georgia and Discovery Islands in May, June and July of 2010 to 2015 varied from 0 to 10.5% during their out-migration through the Strait of Georgia and Discovery Islands.

All Pacific salmon tested for IHN by the Canadian Food Inspection Agency between 2012 and 2014 as part of a program to survey wild and enhanced anadromous salmonids in British Columbia were negative for IHN.

While it occurs in wild salmon, farmed Atlantic salmon are more susceptible to the disease. However, there have been no IHN outbreaks on Atlantic salmon farms in the Discovery Islands since 2003 or in BC since 2012. There has been no detection of IHN in any farmed Atlantic salmon vaccinated against IHN.

-- Can DFO provide a brief update on efforts to combat PRV and HSMI in wild salmon, transferred from farmed salmon?

DFO will be conducting additional risk assessments in the Discovery Islands including an assessment of heart lesions reported on Atlantic salmon farms which will include considerations of PRV and HSMI.

Currently, there are a number of important research projects underway on PRV, its relationship to disease, and its effects on fish. These studies are being led by DFO researchers on both sides of the country.

Laboratory studies in Canada and the US aimed at investigating the disease causing potential of PRV have resulted in different outcomes than those demonstrated in Norway. Differences between Norwegian and North American studies may be due to PRV strain differences, environmental factors, and/or other variables influencing stress and host disease resistance. This is an ongoing, active area of research by DFO.

One DFO study has found evidence of HSMI lesions on a BC Atlantic salmon farm, however, there was no associated elevation in fish mortality. The disease was associated with the presence of PRV, and while this does not mean that PRV causes HSMI, the co-presence is an important finding. The issue of causality, while very recently confirmed in Norway, is still an area of scientific investigation in Canada given the different virus strains, different fish stocks and the lack of success in forcing a disease response.

To date PRV appears to have high transmissibility but low virulence in wild Pacific salmon. However, DFO continues to investigate the disease causing potential of PRV to better understand what effects (if any) PRV has on wild Pacific salmon. Our research is also looking at the presence of other diseases such as jaundice and how they might be related to PRV. The experience of other countries suggests that there is often a complex combination of virus, environmental conditions and host (fish) diseases responses required to result in fish mortality.

Canadians can be confident that their Government is taking this question seriously and we will continue to report our findings and scientific conclusions publically and in a timely manner.

Mimeault, Caroline

From: Mimeault, Caroline
Sent: December 21, 2017 1:23 PM
To: Parsons, Jay; Garver, Kyle
Subject: RE: Draft answer to media request
Attachments: MECTS-#3863619-v2-2017
_SRS_ABAHS_-_Answers_to_media_request_(The_National_Observer).DOCX

Importance: High

Hi,

I made some changes – attached.

To facilitate review, I highlighted the sections for which I would appreciate your feedback Kyle.

I am also copying them below to make it easier:

**-- Will DFO produce similar reports for IHN and the likelihood of infection for other wild Pacific salmon populations?
Why or why not?**

Although the risk assessment focused on the risk to Fraser River sockeye salmon, considerations were given to other fish species susceptible to IHN. Pacific salmon species were not of concern given that they are either less susceptible to IHN than sockeye salmon or not even susceptible to this disease.

**-- When was the last time IHN was detected in Pacific salmon, which kind of salmon, and in what kind of numbers?
(ie: how bad was the problem?)**

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From: Mimeault, Caroline
Sent: December 21, 2017 1:00 PM
To: Parsons, Jay; Garver, Kyle
Subject: Draft answer to media request
Importance: High

First draft. Please have a look.

Kyle – especially the 2nd and 4th question.

Answers from the 5th question came from previous briefings.

Answers for Media Request

Reporter, The National Observer

December 20th, 2017

-- "the likelihood for juvenile Fraser River Sockeye Salmon to be infected and become diseased due to IHNV released from Atlantic Salmon farms is estimated to be extremely unlikely with reasonable uncertainty given current health management practices (i.e., vaccination, surveillance for early detection and depopulation) that limit the amount of potential IHNV shed into the environment from infected farms."

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At this point in time, there are no plans to produce a similar report on IHNV in other Pacific salmon. The next pathogen transfer risk assessments will continue to focus on the risk to Fraser River sockeye salmon resulting from pathogens that caused diseases on Atlantic salmon in the Discovery Islands.

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Canadians can be confident that their Government is taking this question seriously and we will continue to report our findings and scientific conclusions publically and in a timely manner.

Ryan, Patricia

From: Moore, Wayne
Sent: December-21-17 3:02 PM
To: Parsons, Jay; Mimeault, Caroline
Subject: RE: media request on salmon report

Not to put too fine a point on it, I think the PRV one is fine. With regards to #1, is the short answer?

All other things being equal, based on the evidence available, we believe it is extremely unlikely that

Total uncertainty includes both variability, which is a function of the system that is not reducible with additional measurements, and lack of knowledge that can be reduced with additional data or expert opinion (Vose, 2008). Reasonable uncertainty means ...

On #2, why do we not mention Cohen in the response?

On #3, I think we should lead with "Yes, we do check"

From: Parsons, Jay
Sent: December 21, 2017 2:13 PM
To: Moore, Wayne <Wayne.Moore@dfo-mpo.gc.ca>
Subject: FW: media request on salmon report
Importance: High

Wayne, FYI. This will be coming your way soon. Deadline 3 pm. Responses that Caroline and I have developed for some follow up questions from yesterday's briefing. Jay

From: Mimeault, Caroline
Sent: Thursday, December 21, 2017 2:12 PM
To: Jenkins, Phil; Parsons, Jay
Cc: Saindon, Carole
Subject: RE: media request on salmon report
Importance: High

Attached.

From: Jenkins, Phil
Sent: December 21, 2017 1:34 PM
To: Parsons, Jay; Mimeault, Caroline
Cc: Saindon, Carole
Subject: RE: media request on salmon report

Many thanks Jay...I will run it past Wayne and Arran, likely just as an fyi. Then media relations will run up the rest of the way...and then to the journalist.

Phil

From: Parsons, Jay
Sent: December-21-17 1:26 PM
To: Jenkins, Phil <Phil.Jenkins@dfo-mpo.gc.ca>; Mimeault, Caroline <Caroline.Mimeault@dfo-mpo.gc.ca>
Cc: Saindon, Carole <Carole.Saindon@dfo-mpo.gc.ca>
Subject: RE: media request on salmon report

We are working on it. Waiting for Kyle's input. What approval steps do we need to go through. Should I run this by Wayne and Arran or will you?

Jay

From: Jenkins, Phil
Sent: Thursday, December 21, 2017 12:53 PM
To: Parsons, Jay; Mimeault, Caroline
Cc: Saindon, Carole
Subject: RE: media request on salmon report

Hi all...just checking in...how's progress?

From: Jenkins, Phil
Sent: December-21-17 9:18 AM
To: Parsons, Jay <Jay.Parsons@dfo-mpo.gc.ca>
Cc: Garver, Kyle <Kyle.Garver@dfo-mpo.gc.ca>; Mimeault, Caroline <Caroline.Mimeault@dfo-mpo.gc.ca>; Burgetz, Ingrid <Ingrid.Burgetz@dfo-mpo.gc.ca>; Saindon, Carole <Carole.Saindon@dfo-mpo.gc.ca>
Subject: FW: media request on salmon report

Good morning Jay,

We have a follow up media call, below. Deadline is 3 pm today.

I would have cut and pasted our media lines in...but I'm not sure as written and approved, they answer her particular questions.

Over to you for help on this.

Phil

From: Saindon, Carole
Sent: December-21-17 8:58 AM
To: Gilbert, Sarah <Sarah.Gilbert@dfo-mpo.gc.ca>; Chow, Vance <Vance.Chow@dfo-mpo.gc.ca>; Jenkins, Phil <Phil.Jenkins@dfo-mpo.gc.ca>
Cc: Sankey, Lauren <Lauren.Sankey@dfo-mpo.gc.ca>; Burelle, Marie-Pier <Marie-Pier.Burelle@dfo-mpo.gc.ca>; NCR Media RCN (DFO/MPO) <Media.XNCR@dfo-mpo.gc.ca>
Subject: Re: media request on salmon report

Thx! Copying Phil for follow up with Jay's group.

Sent from my BlackBerry 10 smartphone on the Rogers network.

From: NCR Media RCN (DFO/MPO)
Sent: jeudi 21 décembre 2017 8:52 AM

To: Saindon, Carole; Gilbert, Sarah; Chow, Vance
Cc: Sankey, Lauren; Burelle, Marie-Pier
Subject: FW: media request on salmon report

Wasn't sure if this one had already been dealt with...(?)

V.

From: [REDACTED]
Sent: December-20-17 4:50 PM
To: NCR Media RCN (DFO/MPO)
Subject: re: media request on salmon report

Good afternoon,

[REDACTED] here from the National Observer. I hope you're all well.

I'm writing with a deadline of 3 p.m. Eastern on Thursday regarding the IHNv report on Fraser River sockeye published today.

I'm not sure I understand the following sentence:

-- "the likelihood for juvenile Fraser River Sockeye Salmon to be infected and become diseased due to IHNv released from Atlantic Salmon farms is estimated to be **extremely unlikely** with **reasonable uncertainty** given current health management practices (i.e., vaccination, surveillance for early detection and depopulation) that limit the amount of potential IHNv shed into the environment from infected farms."

DFO is reasonably uncertain that it is extremely unlikely? Is there a way someone could reword this so I understand what that means? Much appreciated.

-- Will DFO produce similar reports for IHNv and the likelihood of infection for other wild Pacific salmon populations? Why or why not?

-- In its section on assumptions, DFO says it assumes all regulations, prevention measures, and vaccination rules are being followed by Atlantic salmon farmers when it comes to IHNv. Did it take any steps to verify this?

-- When was the last time IHNv was detected in Pacific salmon, which kind of salmon, and in what kind of numbers? (ie: how bad was the problem?)

-- Can DFO provide a brief update on efforts to combat PRV and HSMI in wild salmon, transferred from farmed salmon?

Thanks for your help!

Best,

[REDACTED]
s.19(1)
[REDACTED]

Reporter, The National Observer

Ottawa | Vancouver | Toronto


Twitter | Website | Blog

s.19(1)

Ryan, Patricia

From: Moore, Wayne
Sent: December-21-17 3:43 PM
To: Jenkins, Phil
Cc: Parsons, Jay; White, Andrea
Subject: FW: FYI: Follow up media call re: CSAS RA
Attachments: MECTS-#3863619-v3-2017
_SRS_ABAHHS_-_Answers_to_media_request_(The_Nation....docx

Importance: High

I am both today....I have added the underlined stuff if people are ok with this.

Answers for Media Request

Reporter, The National Observer
December 20th, 2017

-- "the likelihood for juvenile Fraser River Sockeye Salmon to be infected and become diseased due to IHN released from Atlantic Salmon farms is estimated to be extremely unlikely with reasonable uncertainty given current health management practices (i.e., vaccination, surveillance for early detection and depopulation) that limit the amount of potential IHN shed into the environment from infected farms."

DFO is reasonably uncertain that it is extremely unlikely? Is there a way someone could reword this so I understand what that means? Much appreciated.

To clarify...

Based on the available evidence and current management practices, we are confident that it is extremely unlikely that juvenile Fraser River Sockeye Salmon to be infected and become diseased due to IHN released from Atlantic Salmon farms.

Our uncertainty assessment is a best science practice which comments on the quality of the scientific evidence and the variability of the natural system.

To elaborate:

There were four steps in the likelihood assessment. Each step was first assessed individually and conclusions of all steps were then combined for an overall assessment. The overall conclusion for the likelihood assessment was that it is extremely unlikely that juvenile Fraser River Sockeye Salmon will be infected and become diseased due to IHN released from Atlantic salmon farms.

In addition, the level of uncertainty was assessed for each step. Uncertainty reflects how much each step was based on scientific information, models or expert opinion. There was reasonable uncertainty related to the overall likelihood assessment given some knowledge gaps related to the IHN concentrations on farms during an outbreak which was estimated through modeling and knowledge gaps related to the time juvenile sockeye salmon spend around farms.

However, and most importantly, despite uncertainties in some area of the risk assessment, there is minimal risk to Fraser River sockeye salmon mainly because it is very unlikely that an IHN outbreak on Atlantic salmon farms in the Discovery Islands would occur given that there has been no IHN outbreak on Atlantic salmon farms in the Discovery

Islands since 2003 and given the current effective fish health management practices in place which includes vaccination of all farmed Atlantic salmon against IHNV.

-- Will DFO produce similar reports for IHNV and the likelihood of infection for other wild Pacific salmon populations? Why or why not?

At this point in time, there are no plans to produce a similar report on IHNV in other Pacific salmon. The next pathogen transfer risk assessments will continue to focus on the risk to Fraser River sockeye salmon resulting from pathogens that caused diseases on Atlantic salmon in the Discovery Islands as recommended by the Cohen Commission.

Although the risk assessment focused on the risk to Fraser River sockeye salmon, considerations were given to other fish species susceptible to IHN. Pacific salmon species were not of concern given that they are either less susceptible to IHN than sockeye salmon or not even susceptible to this disease.

-- In its section on assumptions, DFO says it assumes all regulations, prevention measures, and vaccination rules are being followed by Atlantic salmon farmers when it comes to IHNV. Did it take any steps to verify this?

Yes we regularly check a number of these items. Under the Pacific Aquaculture Regulations, the licence conditions include the requirement for a Salmonid Health Management Plan and accompanying Standard Operating Procedures which are reviewed and approved by DFO as a part of the initial licence application. Additionally, DFO conducts audits of farms under the Fish Health Audit and Surveillance Program on a regular basis. During the audits, the activities, protocols and procedures are reviewed and fish samples are collected for pathogen diagnosis. A summary of the audit results are available on the DFO website.

It is in the interest of the company to ensure the health of farmed fish. To that end, in addition to meeting conditions of licence, Atlantic salmon companies operating in the Discovery Islands developed and agreed to a Salmon Farming Industry Viral Disease Management Plan which includes procedures to prevent or minimize the spread of disease in the event of an outbreak. This agreement includes the vaccination of all farmed Atlantic salmon against IHN. Additionally, all active Atlantic salmon farms in the Discovery Islands are certified by a third party eco-certification program that requires all fish to be vaccinated against diseases for which effective vaccines are available.

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From: Jenkins, Phil

Sent: December 21, 2017 3:03 PM

To: McPherson, Arran <Arran.McPherson@dfo-mpo.gc.ca>; Moore, Wayne <Wayne.Moore@dfo-mpo.gc.ca>

Cc: Saindon, Carole <Carole.Saindon@dfo-mpo.gc.ca>; White, Andrea <Andrea.White@dfo-mpo.gc.ca>

Subject: FYI: Follow up media call re: CSAS RA

Importance: High

Hi Arran and Wayne,

We had a follow up call on the briefing yesterday. Jay's group has put together this response attached. Please flag any show-stoppers... [REDACTED]

Thanks,

Phil

Phil Jenkins

A/Mgr. | Gestionnaire intérimaire

Strategic Communications – Ecosystems and Oceans Science | Communications stratégiques – Sciences des écosystèmes et des océans

Fisheries and Oceans Canada | Pêches et Océans Canada Communications (Science)

613-991-0323

s.19(1)

s.21(1)(b)

Answers for Media Request

Reporter, The National Observer

December 20th, 2017

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Although the risk assessment focused on the risk to Fraser River sockeye salmon, considerations were given to other fish species susceptible to IHN. Pacific salmon species were not of concern given that they are either less susceptible to IHN than sockeye salmon or not even susceptible to this disease.

-- In its section on assumptions, DFO says it assumes all regulations, prevention measures, and vaccination rules are being followed by Atlantic salmon farmers when it comes to IHN. Did it take any steps to verify this?

Under the Pacific Aquaculture Regulations, the licence conditions include the requirement for a Salmonid Health Management Plan and accompanying Standard Operating Procedures which are reviewed and approved by DFO as a part of the initial licence application. Additionally, DFO conducts audits of farms under the Fish Health Audit and Surveillance Program on a regular basis. During the audits, the activities, protocols and procedures are reviewed and fish samples are collected for pathogen diagnosis. A summary of the audit results are available on the DFO website.

It is in the interest of the company to ensure the health of farmed fish. To that end, in addition to meeting conditions of licence, Atlantic salmon companies operating in the Discovery Islands developed and agreed to a Salmon Farming Industry Viral Disease Management Plan which includes procedures to prevent or minimize the spread of disease in the event of an outbreak. This agreement includes the vaccination of all farmed Atlantic salmon against IHN. Additionally, all active Atlantic salmon farms in the Discovery Islands are certified by a third party eco-certification program that requires all fish to be vaccinated against diseases for which effective vaccines are available.

-- When was the last time IHN was detected in Pacific salmon, which kind of salmon, and in what kind of numbers? (ie: how bad was the problem?)

IHN is endemic to the Pacific Northwest, meaning it is native to the environment.

Long-term monitoring of British Columbia sockeye salmon stocks from the Skeena, Fraser, and Columbia River watersheds conducted by DFO revealed that annual prevalence of IHN in spawning adult sockeye salmon is highly variable within and among stocks. For example, between 1987 and 2015, prevalence of IHN in spawning adults varied from 0 to 50% (average of 9%) in Weaver Creek and from 0 to 62% (average of 11%) in Nadina River.

Prevalence of IHN in juvenile Fraser River sockeye salmon collected by DFO during surveys conducted in the Strait of Georgia and Discovery Islands in May, June and July of 2010 to 2015 varied from 0 to 10.5% during their out-migration through the Strait of Georgia and Discovery Islands.

All Pacific salmon tested for IHN by the Canadian Food Inspection Agency between 2012 and 2014 as part of a program to survey wild and enhanced anadromous salmonids in British Columbia were negative for IHN.

While it occurs in wild salmon, farmed Atlantic salmon are more susceptible to the disease. However, there have been no IHN outbreaks on Atlantic salmon farms in the Discovery Islands since 2003 or in BC since 2012. There has been no detection of IHN in any farmed Atlantic salmon vaccinated against IHN.

-- Can DFO provide a brief update on efforts to combat PRV and HSMI in wild salmon, transferred from farmed salmon?

DFO will be conducting additional risk assessments in the Discovery Islands including an assessment of the risks to Fraser River sockeye salmon associated with heart lesions reported on Atlantic salmon farms. This assessment will include considerations of PRV and HSML.

Currently, there are a number of important research projects underway on PRV, its relationship to disease, and its effects on fish. These studies are being led by DFO researchers on both sides of the country.

Laboratory studies in Canada and the US aimed at investigating the disease causing potential of PRV have resulted in different outcomes than those demonstrated in Norway. Differences between Norwegian and North American studies may be due to PRV strain differences, environmental factors, and/or other variables influencing stress and host disease resistance. To date PRV appears to have high transmissibility but low virulence in wild Pacific salmon. This is an ongoing, active area of research by DFO.

Ryan, Patricia

From: Moore, Wayne
Sent: December-21-17 3:57 PM
To: Mimeault, Caroline; Jenkins, Phil
Cc: Parsons, Jay
Subject: RE: FYI: Follow up media call re: CSAS RA

I am fine with this version fill with one change. I think we need to be clear that the answer to #3 is Yes we do check and then go over details.

From: Mimeault, Caroline
Sent: December 21, 2017 3:55 PM
To: Jenkins, Phil <Phil.Jenkins@dfo-mpo.gc.ca>; Moore, Wayne <Wayne.Moore@dfo-mpo.gc.ca>
Cc: Parsons, Jay <Jay.Parsons@dfo-mpo.gc.ca>
Subject: RE: FYI: Follow up media call re: CSAS RA

Attached including Wayne and Kyle's comments highlighted in yellow.

From: Parsons, Jay
Sent: December 21, 2017 3:46 PM
To: Mimeault, Caroline
Subject: Fw: FYI: Follow up media call re: CSAS RA
Importance: High

From: Moore, Wayne
Sent: Thursday, December 21, 2017 03:42 PM
To: Jenkins, Phil
Cc: Parsons, Jay; White, Andrea
Subject: FW: FYI: Follow up media call re: CSAS RA

I am both today....I have added the underlined stuff if people are ok with this.

Answers for Media Request

 Reporter, The National Observer
December 20th, 2017

-- "the likelihood for juvenile Fraser River Sockeye Salmon to be infected and become diseased due to IHNV released from Atlantic Salmon farms is estimated to be extremely unlikely with reasonable uncertainty given current health management practices (i.e., vaccination, surveillance for early detection and depopulation) that limit the amount of potential IHNV shed into the environment from infected farms."

DFO is reasonably uncertain that it is extremely unlikely? Is there a way someone could reword this so I understand what that means? Much appreciated.

To clarify...

s.19(1)

Based on the available evidence and current management practices, we are confident that it is extremely unlikely that juvenile Fraser River Sockeye Salmon to be infected and become diseased due to IHN released from Atlantic Salmon farms.

Our uncertainty assessment is a best science practice which comments on the quality of the scientific evidence and the variability of the natural system.

To elaborate:

There were four steps in the likelihood assessment. Each step was first assessed individually and conclusions of all steps were then combined for an overall assessment. The overall conclusion for the likelihood assessment was that it is extremely unlikely that juvenile Fraser River Sockeye Salmon will be infected and become diseased due to IHN released from Atlantic salmon farms.

In addition, the level of uncertainty was assessed for each step. Uncertainty reflects how much each step was based on scientific information, models or expert opinion. There was reasonable uncertainty related to the overall likelihood assessment given some knowledge gaps related to the IHN concentrations on farms during an outbreak which was estimated through modeling and knowledge gaps related to the time juvenile sockeye salmon spend around farms.

However, and most importantly, despite uncertainties in some area of the risk assessment, there is minimal risk to Fraser River sockeye salmon mainly because it is very unlikely that an IHN outbreak on Atlantic salmon farms in the Discovery Islands would occur given that there has been no IHN outbreak on Atlantic salmon farms in the Discovery Islands since 2003 and given the current effective fish health management practices in place which includes vaccination of all farmed Atlantic salmon against IHN.

-- Will DFO produce similar reports for IHN and the likelihood of infection for other wild Pacific salmon populations? Why or why not?

At this point in time, there are no plans to produce a similar report on IHN in other Pacific salmon. The next pathogen transfer risk assessments will continue to focus on the risk to Fraser River sockeye salmon resulting from pathogens that caused diseases on Atlantic salmon in the Discovery Islands as recommended by the Cohen Commission.

Although the risk assessment focused on the risk to Fraser River sockeye salmon, considerations were given to other fish species susceptible to IHN. Pacific salmon species were not of concern given that they are either less susceptible to IHN than sockeye salmon or not even susceptible to this disease.

-- In its section on assumptions, DFO says it assumes all regulations, prevention measures, and vaccination rules are being followed by Atlantic salmon farmers when it comes to IHN. Did it take any steps to verify this?

Yes we regularly check a number of these items. Under the Pacific Aquaculture Regulations, the licence conditions include the requirement for a Salmonid Health Management Plan and accompanying Standard Operating Procedures which are reviewed and approved by DFO as a part of the initial licence application. Additionally, DFO conducts audits of farms under the Fish Health Audit and Surveillance Program on a regular basis. During the audits, the activities, protocols and procedures are reviewed and fish samples are collected for pathogen diagnosis. A summary of the audit results are available on the DFO website.

It is in the interest of the company to ensure the health of farmed fish. To that end, in addition to meeting conditions of licence, Atlantic salmon companies operating in the Discovery Islands developed and agreed to a Salmon Farming Industry Viral Disease Management Plan which includes procedures to prevent or minimize the spread of disease in the event of an outbreak. This agreement includes the vaccination of all farmed Atlantic salmon against IHN. Additionally, all active Atlantic salmon farms in the Discovery Islands are certified by a third party eco-certification program that requires all fish to be vaccinated against diseases for which effective vaccines are available.

-- When was the last time IHNV was detected in Pacific salmon, which kind of salmon, and in what kind of numbers? (ie: how bad was the problem?)

IHNV is endemic to the Pacific Northwest, meaning it is native to the environment.

Long-term monitoring of British Columbia sockeye salmon stocks from the Skeena, Fraser, and Columbia River watersheds conducted by DFO revealed that annual prevalence of IHNV in spawning adult sockeye salmon is highly variable within and among stocks. For example, between 1987 and 2015, prevalence of IHNV in spawning adults varied from 0 to 50% (average of 9%) in Weaver Creek and from 0 to 62% (average of 11%) in Nadina River.

Prevalence of IHNV in juvenile Fraser River sockeye salmon collected by DFO during surveys conducted in the Strait of Georgia and Discovery Islands in May, June and July of 2010 to 2015 varied from 0 to 10.5% during their out-migration through the Strait of Georgia and Discovery Islands.

All Pacific salmon tested for IHNV by the Canadian Food Inspection Agency between 2012 and 2014 as part of a program to survey wild and enhanced anadromous salmonids in British Columbia were negative for IHNV.

While it occurs in wild salmon, farmed Atlantic salmon are more susceptible to the disease. However, there have been no IHNV outbreaks on Atlantic salmon farms in the Discovery Islands since 2003 or in BC since 2012. There has been no detection of IHNV in any farmed Atlantic salmon vaccinated against IHNV.

-- Can DFO provide a brief update on efforts to combat PRV and HSMI in wild salmon, transferred from farmed salmon?

DFO will be conducting additional risk assessments in the Discovery Islands including an assessment of the risks to Fraser River sockeye salmon associated with heart lesions reported on Atlantic salmon farms. This assessment will include considerations of PRV and HSMI.

Currently, there are a number of important research projects underway on PRV, its relationship to disease, and its effects on fish. These studies are being led by DFO researchers on both sides of the country.

Laboratory studies in Canada and the US aimed at investigating the disease causing potential of PRV have resulted in different outcomes than those demonstrated in Norway. Differences between Norwegian and North American studies may be due to PRV strain differences, environmental factors, and/or other variables influencing stress and host disease resistance. To date PRV appears to have high transmissibility but low virulence in wild Pacific salmon. This is an ongoing, active area of research by DFO.

From: Jenkins, Phil

Sent: December 21, 2017 3:03 PM

To: McPherson, Arran <Arran.McPherson@dfo-mpo.gc.ca>; Moore, Wayne <Wayne.Moore@dfo-mpo.gc.ca>

Cc: Saindon, Carole <Carole.Saindon@dfo-mpo.gc.ca>; White, Andrea <Andrea.White@dfo-mpo.gc.ca>

Subject: FYI: Follow up media call re: CSAS RA

Importance: High

Hi Arran and Wayne,

We had a follow up call on the briefing yesterday. Jay's group has put together this response attached. Please flag any show-stoppers... [REDACTED]

Thanks,

Phil

s.19(1)

s.21(1)(b)

Phil Jenkins

A/Mgr. | Gestionnaire intérimaire

Strategic Communications – Ecosystems and Oceans Science | Communications stratégiques – Sciences des écosystèmes et des océans

Fisheries and Oceans Canada | Pêches et Océans Canada Communications (Science)

613-991-0323

Ryan, Patricia

From: Moore, Wayne
Sent: December-27-17 2:00 PM
To: Lowe, Carmel
Cc: Parsons, Jay
Subject: [REDACTED]

Let us know if we can be of assistance. |

From: Lowe, Carmel
Sent: December 27, 2017 1:10 PM
To: McPherson, Arran <Arran.McPherson@dfo-mpo.gc.ca>; Reid, Rebecca <Rebecca.Reid@dfo-mpo.gc.ca>
Cc: Thomson, Andrew <Andrew.Thomson@dfo-mpo.gc.ca>; Moore, Wayne <Wayne.Moore@dfo-mpo.gc.ca>; Taylor, Nathan <Nathan.Taylor@dfo-mpo.gc.ca>; MacDougall, Lesley <Lesley.MacDougall@dfo-mpo.gc.ca>
Subject: [REDACTED]

Importance: High

Arran & Rebecca,

See below [REDACTED]

[REDACTED]

I will provide an estimate of expected completion [REDACTED] once all staff are back on strength from the hols.

[REDACTED]

Carmel

Carmel Lowe, Ph.D.
Regional Director Science | Directrice régionale des sciences
Fisheries and Oceans Canada | Pêches et Océans Canada
Pacific Biological Station | Station biologique du Pacifique
3190 Hammond Bay Rd, Nanaimo, BC, Canada V9T 6N7

s.21(1)(a)

s.21(1)(b)

s.23

Carmel.Lowe@dfo-mpo.gc.ca

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Facsimile | Télécopieur 250-729-8360

Government of Canada | Gouvernement du Canada

From: Townsend, Jill

Sent: Friday, December 22, 2017 3:53 PM

To: Lowe, Carmel <Carmel.Lowe@dfo-mpo.gc.ca>; Thomson, Andrew <Andrew.Thomson@dfo-mpo.gc.ca>

Cc: Lavigne, Lauren <Lauren.Lavigne@dfo-mpo.gc.ca>; Taylor, Nathan <Nathan.Taylor@dfo-mpo.gc.ca>; Owens, Heather <Heather.Owens@dfo-mpo.gc.ca>; Jackson, Corey <Corey.Jackson@dfo-mpo.gc.ca>; Ikejiani, Alexander <Alexander.Ikejiani@dfo-mpo.gc.ca>

Subject: [REDACTED]

Importance: High

Carmel, and Andy,

Jill Townsend

Litigation Case Manager, Litigation Unit, Fisheries & Oceans Canada | Pêches et Océans Canada, Pacific Regional Office | Région du Pacifique, 200-401 Burrard Street | 401 rue Burrard, Pièce 200, Vancouver, BC V6C 3S4, Jill.Townsend@dfo-mpo.gc.ca Telephone | Téléphone (604) 658-2843, Cell | [REDACTED] Government of Canada | Gouvernement du Canada

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s.16(2)(c)

s.21(1)(a)

s.21(1)(b)

s.23

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23

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Ryan, Patricia

From: Moore, Wayne
Sent: December-27-17 2:01 PM
To: Parsons, Jay
Subject: [REDACTED]

Attachments: [REDACTED]

Importance: High

fyi

From: Lowe, Carmel
Sent: December 27, 2017 1:10 PM
To: McPherson, Arran <Arran.McPherson@dfo-mpo.gc.ca>; Reid, Rebecca <Rebecca.Reid@dfo-mpo.gc.ca>
Cc: Thomson, Andrew <Andrew.Thomson@dfo-mpo.gc.ca>; Moore, Wayne <Wayne.Moore@dfo-mpo.gc.ca>; Taylor, Nathan <Nathan.Taylor@dfo-mpo.gc.ca>; MacDougall, Lesley <Lesley.MacDougall@dfo-mpo.gc.ca>
Subject: [REDACTED]
[REDACTED]
Importance: High

Arran & Rebecca,

[REDACTED]

I will provide an estimate of expected completion [REDACTED] once all staff are back on strength from the hols.

[REDACTED]

Carmel

Carmel Lowe, Ph.D.
Regional Director Science | Directrice régionale des sciences

s.21(1)(a)

s.21(1)(b)

s.23

Fisheries and Oceans Canada | Pêches et Océans Canada
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Facsimile | Télécopieur 250-729-8360

Government of Canada | Gouvernement du Canada

From: Townsend, Jill

Sent: Friday, December 22, 2017 3:53 PM

To: Lowe, Carmel <Carmel.Lowe@dfo-mpo.gc.ca>; Thomson, Andrew <Andrew.Thomson@dfo-mpo.gc.ca>

Cc: Lavigne, Lauren <Lauren.Lavigne@dfo-mpo.gc.ca>; Taylor, Nathan <Nathan.Taylor@dfo-mpo.gc.ca>; Owens, Heather <Heather.Owens@dfo-mpo.gc.ca>; Jackson, Corey <Corey.Jackson@dfo-mpo.gc.ca>; Ikejiani, Alexander <Alexander.Ikejiani@dfo-mpo.gc.ca>

Subject: [REDACTED]

Importance: High

Carmel, and Andy,

Jill Townsend

Litigation Case Manager, Litigation Unit, Fisheries & Oceans Canada | Pêches et Océans Canada, Pacific Regional Office | Région du Pacifique, 200-401 Burrard Street | 401 rue Burrard, Pièce 200, Vancouver, BC V6C 3S4, Jill.Townsend@dfo-mpo.gc.ca Telephone | Téléphone (604) 658-2843, Cell | [REDACTED] Government of Canada | Gouvernement du Canada

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s.16(2)(c)

s.21(1)(a)

s.21(1)(b)

s.23

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sont des duplicatas des
pages 1904 to / à 1911**

**Pages 1955 to / à 1959
are withheld pursuant to sections
sont retenues en vertu des articles**

21(1)(b), 23, 21(1)(a)

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de la Loi sur l'accès à l'information**

Page 1960

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est retenue en vertu des articles**

21(1)(b), 16(2)(c), 23, 21(1)(a)

**of the Access to Information Act
de la Loi sur l'accès à l'information**

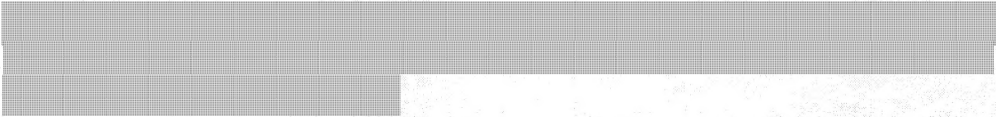
Page 1961

**is withheld pursuant to section
est retenue en vertu de l'article**

23

**of the Access to Information Act
de la Loi sur l'accès à l'information**

McLeod, Patricia

From: Lowe, Carmel
Sent: December 28, 2017 2:44 PM
To: McPherson, Arran
Cc: Thomson, Andrew; Taylor, Nathan; Moore, Wayne
Subject: RE: draft email
Attachments: 

This time with attachments...

Carmel

Carmel Lowe, Ph.D.
Regional Director Science | Directrice régionale des sciences
Fisheries and Oceans Canada | Pêches et Océans Canada
Pacific Biological Station | Station biologique du Pacifique
3190 Hammond Bay Rd, Nanaimo, BC, Canada V9T 6N7

s.14(a)

s.19(1)

s.21(1)(a)

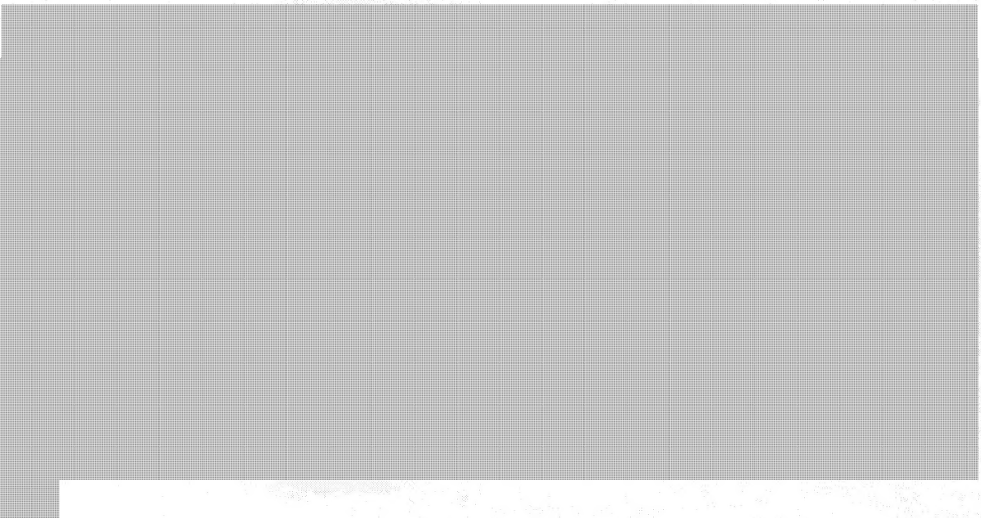
s.21(1)(b)

s.23

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Facsimile | Télécopieur 250-729-8360
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From: Lowe, Carmel
Sent: Thursday, December 28, 2017 2:41 PM
To: McPherson, Arran <Arran.McPherson@dfo-mpo.gc.ca>
Cc: Thomson, Andrew <Andrew.Thomson@dfo-mpo.gc.ca>; Taylor, Nathan <Nathan.Taylor@dfo-mpo.gc.ca>; Moore, Wayne <Wayne.Moore@dfo-mpo.gc.ca>
Subject: FW: draft email

Arran,

Want to provide you with an update 

Carmel

Carmel Lowe, Ph.D.
Regional Director Science | Directrice régionale des sciences
Fisheries and Oceans Canada | Pêches et Océans Canada
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s.14(a)

s.19(1)

s.21(1)(a)

s.21(1)(b)

s.23

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